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THE ELECTRIC LIGHTING ACT.

A COMMITTEE is in process of formation—if it has not already been formed—for the purpose of drawing up clauses, in accordance with the suggestion of the President of the Board of Trade, embodying the modifications desired in the Electric Lighting Act and the Provisional Orders. Pending the submission of the views of this Committee to the Board of Trade we venture to recur to the subject of the 27th section of the Act, which deals with the compulsory purchase of an electric light undertaking by a local authority at the end of twenty-one years, and the terms of such purchase. Last week we expressed our opinion that those terms were not equitable, and were calculated to prevent the development of public lighting. It is imperative, if work of this kind is to be carried out, that either the time should be extended or some allowance be made for the goodwill of the undertakers. A correspondent of a contemporary draws attention to what he considers a parallel case to this of electric lighting, in which the terms of purchase afford a singular contrast to those insisted upon by the Act under discussion. Thirty years ago, the financial practicability of railway enterprise in India was purely hypothetical. Experimentally and tentatively some progress had been made; the public, however, were not easily to be convinced that railway works could be successfully maintained under the climatic and physical conditions of the country, and what is still more to the point, the problem still awaited solution, how far the natives could make use of the accommodation to be provided. The Indian Government were desirous of attracting private capital to the enterprise, but for this it was necessary not only to confer a monopoly of powers, but to give a substantial pecuniary guarantee. In consenting to this sacrifice the Government were far-seeing enough to reserve to themselves an option of purchase, but the terms were carefully considered so as to be fair and not repellent to inventors. The final contract of the Indian Government with the East Indian Railway Company was made in 1854. The Government guaranteed a minimum dividend of £5 per cent.; surplus profits over that amount in any year were to be shared, one-half to go towards recouping the Government for their outlay on the guarantee, and the other half to increase the dividend. And there was to be an option of purchase by the Government, to be exercised by notice to be given within six months after the expiration of twenty-five years, or within six months after the expiration of fifty years, the purchase money to be "a sum equal to the full amount of the value of all the shares and capital stock in the company calculated *according to the mean market value in London of such shares or stock during the three years immediately preceding* the expiration of the said period of twenty-five years, or the said period of fifty years, as the case might be." The capital was subscribed on the strength of this contract, and the undertaking carried out. After some years the profits were found frequently to exceed the guaranteed amount, so that, after dividing the surplus with the Government according to the arrangement, a dividend of ½, 1, or even 2 per cent. over the guaranteed 5 per cent. was paid to the shareholder. The stock improved steadily, and, as the time came near for exercising the option, stood at about 25 per cent. premium. The new arrangement (which is confirmed by an Act of the Imperial Parliament, 43 and 44 Vict., cap. ccvi.) took effect from January 1st, 1880; and the Government acquired at the price of 25 per cent. premium—perhaps at an expenditure including the amount expended under the guarantee of 50 per cent. in all over the original cost—an undertaking of proved and increasing value, with the accumulated fruits of experience and successful management, in every respect a remunerative purchase. Indeed, so greatly was the success attributed to the private management that the company retains an interest in the undertaking, which is still carried on by the directors of the company on behalf of the Government.

There is a very good case for the contention that a monopoly does not necessarily act detrimentally to the public service, and that the restrictive effect of the option of purchase granted to the local authority is greater than any benefits likely to accrue therefrom; but, in face of the definite statement made by Mr. Chamberlain, it is needless to go into that question, and consequently we confine ourselves to calling attention to the case cited above, which shows the terms on which such an option can be made consistent with the encouragement of private enterprise. As the correspondent to whom we have alluded remarks, that the Indian Government, in new railway undertakings, can and does impose harder terms, is only an illustration of the difference between a new and untried enterprise and an undertaking on which the profits can be estimated by matured experience. This difference at once disposes of the supposed analogy between electric lighting and gas and water supply.

ALTERNATING CURRENT MACHINES.

THE recent papers read before the Society of Telegraph Engineers, by Dr. Hopkinson and Prof. W. G. Adams, on Alternating Current Machines, were in many respects highly interesting, and several points which deserve attention and further elucidating were touched upon. A great deal has been said and written with reference to the dangers of alternating currents, but, as Dr. Hopkinson pointed out, we have as yet no conclusive evidence that the danger arises simply from the fact of the machine being an alternating and not a direct current one. The accidents that have taken

place have in every instance been caused by machines generating a high potential, and it is quite possible that had this high potential been produced from a direct current apparatus, equally fatal results might have ensued. In an alternating current machine the actual difference of potential which takes place is that from the highest negative to the highest positive; consequently a direct current machine of double the nominal potential of the alternate current one, should be taken as a standard of comparison; thus a 2,000volt alternating dynamo would correspond to a 4,000 volt direct current apparatus. Prof. Adams mentioned that a full shock from a 75 volt De Meritens alternating machine was received by an attendant at the South Foreland, and no evil results were caused by it, a fact which goes far to prove that the popular idea on the subject is incorrect. The impossibility of charging accumulators from the machines in question must to a great extent limit their general employment, as the so-called storage of electricity is steadily becoming a point of the very highest importance in electric light installations. Another consideration, which seems likely to limit the utility of the alternate current principle, is the influence which the electrostatic capacity of the leading wires has in reducing the power transmitted to the further end. Mr. Blakesley stated that supposing the alternations of the current to be 200 per minute, a lead (of a particular dimension) about two miles long, and insulated with Hooper's rubber, could reduce the transmitted effect by one-half, *i.e.*, a dynamometer placed at the further end of the lead would give one-half the indication of one placed at the transmitting end. This statement, however, seems somewhat contradicted by the fact that in the Gaulard and Gibbs system the alternations have been transmitted a distance of 15 miles, with, it is said, but comparatively little diminution of effect. The fact discovered by Dr. Hopkinson, and also some years ago by Mr. Wilde, that alternating current machines can be run together without mechanical couplings is a remarkable one, and is another instance of how the best, and apparently impossible, effects are produced by the simplest means.

AERIAL NAVIGATION.

IN a communication by Monsieur D. Stapfer, engineer, to the Genie Civil, he maintains that whatever be the practical value of Captain Renard's aerial ship with electrical motor, it is interesting to note that he has demonstrated the possibility of calculating the elements of the aerial ship according to the formulæ used in water navigation. Thus the experiments of the 9th of August last have demonstrated that the resistance per square meter of midship section is in direct proportion to the densities of the fluids. That is to say, that the air having a density 800 times less than sea water, the engine which could propel 800 square metres section in the air could only propel one square metre immersed in the water. In fact, if to the air ship is applied the well-known formula:

$$V = m\sqrt[3]{\frac{F}{B^2}},$$

W find V = 5·50 m. per second = 11 knots per hour.
F = 250 kilogrammetres = 3·3 horse power.
B^2 = 55 square metres, or 0·0687 of water.

From which the coefficient m is found to equal 3·00, which corresponds to the factor used in a ship of full body. Monsieur Stapfer, therefore, concludes that in future it will be an easy matter to predict the velocity which an aerial ship can attain according to the gross power developed by the motor, save such changes as are due to fineness of form or disposition of motor. But it remains an acquired fact that for an air ship of 2,000 kilogrammes of ascensional force it requires 3½ horse-power to overcome a wind of six metres per second velocity, popularly termed "a good breeze for driving windmills." Thus, to overcome an aerial current of nine metres per second, it will be necessary to develop 12 horse-power, as Messrs. Renard and Krebs had predicted; and Monsieur Stapfer regrets that, having had an electric motor capable of developing as its limit 12 horse-power for over an hour, they did not continue the voyage until they had exhausted their power, and were contented to develop only a little more than three horse-power during 25 minutes.

THE TROUVÉ ELECTRIC UNIVERSAL LAMPS.

By C. CHASSEVENT.

Paris: J. BAUDRY (*Lampes Electriques Universelles Trouvé*).

IT will be generally admitted that there are many cases in which a portable lamp, capable of burning in an air-tight case, and consequently incapable of igniting combustible or explosive gases or vapours, will be of very great utility. In powder magazines, in workshops and warehouses where alcohol, ether, benzol, oil of turpentine, and a whole series of volatile and inflammable liquids are made or stored up, the use of any ordinary light is inadmissible, and such places, consequently, can only be entered by daylight, or by the aid of complicated and costly contrivances. In coal mines of a suspicious character a daily inspection is often requisite before the men can begin their work, and this process requires a good and safe light. Even in private houses the need for some perfectly secure source of light not unfrequently arises. Suppose that in the night, or before daybreak, the smell of escaping gas is detected. It becomes necessary to go round, opening the windows and examining if any gas tap has been inadvertently left partially turned on. If the person who undertakes this duty goes about with a lighted candle, or strikes a match in the room which is the seat of the escape, an explosion, often serious and possibly fatal, is the result.

No small honour, therefore, belongs to M. Trouvé for the invention of his portable electric lamp. These lamps are not bulkier or heavier than an ordinary oil lamp, and as they contain within themselves the source of electricity, no wire connects them to any fixed point. Hence they can be conveyed to any distance.

Fig. 1 shows the Trouvé "universal" lamp in action. A, B, are buttons which fix the rod, C, to the box, D, and the leather strap, F, is a jointed handle for hanging up the apparatus or transporting it when not in action.

To ensure safety the electric lamp placed upon the apparatus is enclosed in a double case of strong glass, which is again secured by a cage or lantern of metal rods. The arrangement of the apparatus is such that no commutator being necessary, no electric sparks can play between the different parts. Thus the security is absolute.

The Trouvé lamps are kindled and extinguished automatically; that is to say they become luminous either as soon as they are taken in the hand, or otherwise when they are set down upon a table or any other support. There are, in fact, two distinct types of this apparatus; one which is lighted when placed upon a table, and another which is lighted when taken in the hand and extinguished on being set down. In both cases the lighting and the extinguishing are automatic, requiring nothing to be done by hand.

A screw-button, which can be turned up or down, serves to regulate the intensity of the light from the feeble glimmer of a night-light to the lustre of four or five candles.

Lest any accident should happen from the escape or overflow of the liquid contained in the apparatus it is fitted with a simple and ingenious arrangement which makes it capable even of being inverted without injury.

The same kind of lamp is shown when out of action in fig. 2. The letters of reference have the same mean-

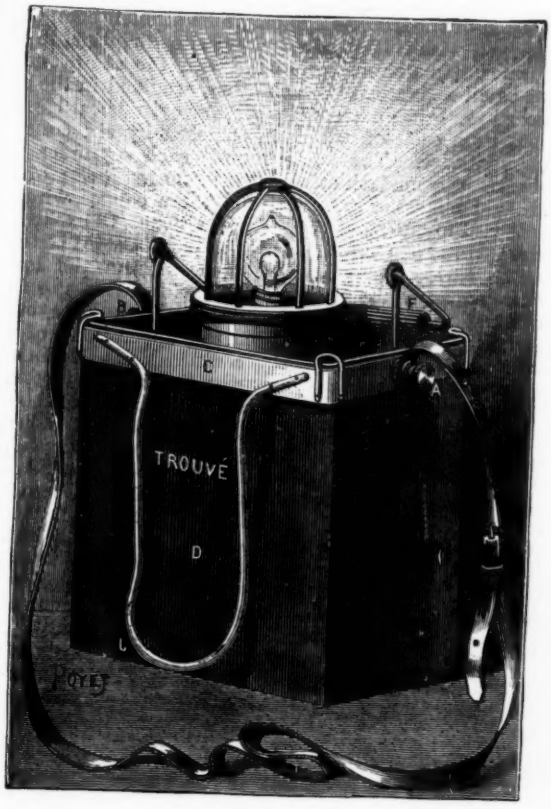


FIG. 1.

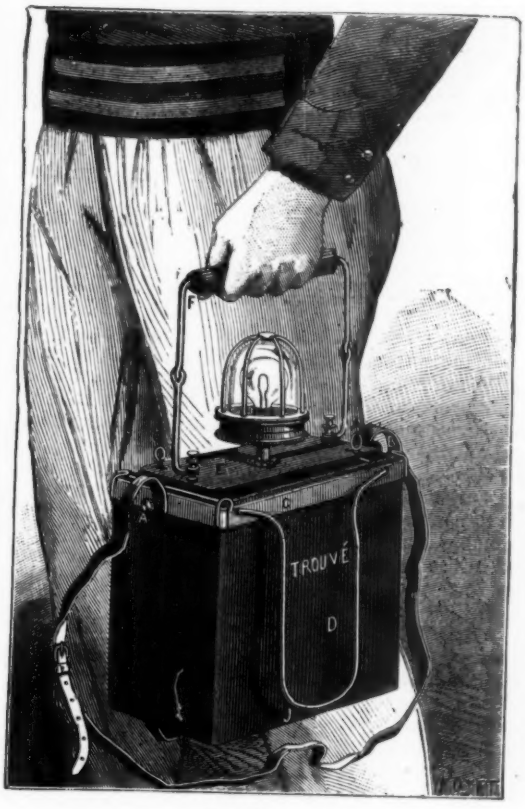


FIG. 2.

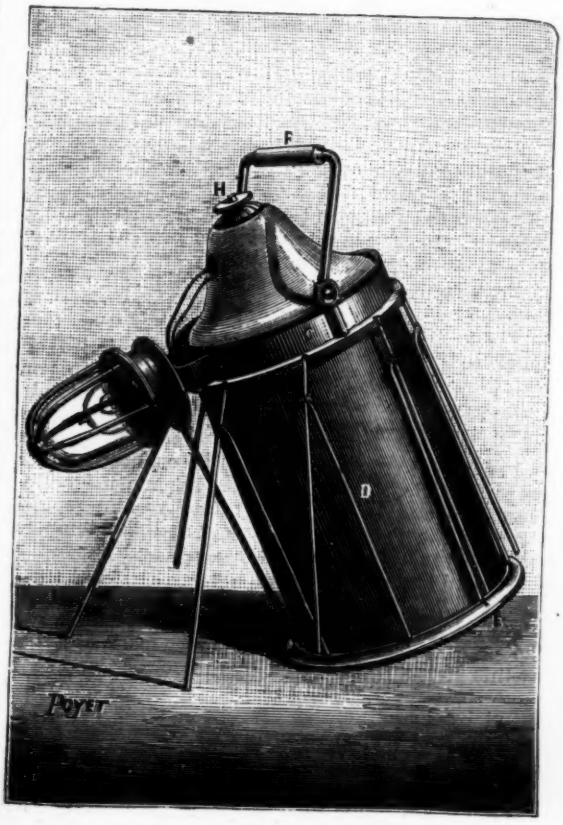


FIG. 3.

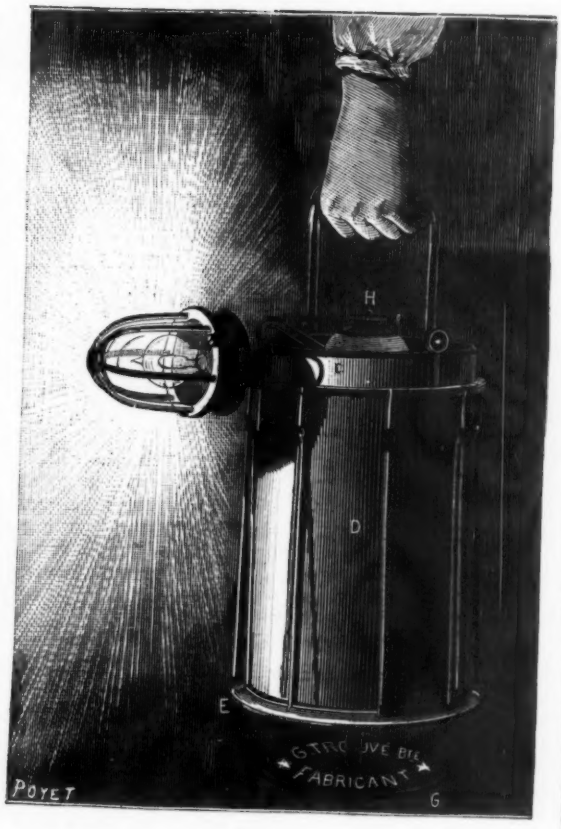


FIG. 4.

ing, except that E is the cover under which the elements are fixed in tension, and G, H are two small keys by which the automatic action of the lamp can be suspended at will.

In both types of lamps the apparatus is composed of a vessel with compartments forming the receptacle of a special bichromate battery, also devised by M. Trouvé. The cover containing the elements can ascend and descend in the vessel which holds the exciting liquid, and by this movement the lamp is kindled, extinguished and regulated.

In the apparatus of the first type when the cover descends the current is set up and the lamp is lighted (fig. 1). If the lid is raised the elements of the battery are no longer immersed in the exciting liquid, the current ceases and the lamp is extinguished (fig. 2). If we then imagine a handle fixed to the lid—and prevented by one or more stops from entirely leaving the vessel—we easily imagine how the lamp is extinguished when suspended or carried by the handle, whilst it is re-kindled as soon as it is secured to the belt by the hook, J, fixed on D.

This type is especially designed for the use of firemen, gas-men, miners, and, in general, for persons required to penetrate into places filled with explosive or inflammable matter. It does not act whilst being carried in the hand, but throws out a bright light when hooked to the belt so that the man may have both his hands at liberty.

The apparatus of the second type—those which light up when taken in the hand—are of a round form, and especially adapted for domestic use (fig. 3). A lamp of this kind not in action is shown in fig. 3. Its automatic function is due to a disc and a central rod, which raise the elements when the lamp is set on its base. On the other hand the elements re-descend by their own weight when the apparatus is raised by the handle, F. The regulation is effected by the milled head, H, which causes the elements to penetrate more or less deeply into the exciting fluid.

Fig. 4 shows the same lamp in action. The lateral position of the lantern enables the light to be better utilised.

These lamps serve for three hours, giving, as was said, the light of four to five candle. The inventor has not attempted to employ them for solving the problem of a constant illumination. They are intended for intermittent use, and in this capacity they will be found exceedingly useful.

STURGEON'S ELECTRO-MAGNETIC ENGINE FOR TURNING MACHINERY.

THE following is a description, reproduced from the *Engineer* of November 14th, of Sturgeon's electro-magnetic engine, one of the first electro-motors ever produced, from Sturgeon's "Annals of Electricity," October, 1836, Vol. I., p. 75 :—

"Fig. 17 represents a stout square board, which forms the base of the engine. In two opposite corners of the base board are fixed the two upright pillars, which carry a cross piece. In this cross piece are fixed two other smaller pillars, which also carry a cross piece. In the centre of the engine is a vertical shaft, which turns freely in two metallic collars, one of which is in the centre of the base board, and the other in the centre of the cross piece. About half way up the shaft are two circular channels, one above the other, as seen in the figure. Through the centre of these channels, and at right angles to their planes, the shaft passes, and is fixed to them. Lower down, the shaft passes through the centre of an opening in the cross piece, also supported by two short pillars. On this cross piece, and concentric with the shaft, are fixed four quadrantal metallic plates, separated from each other by narrow radial openings. Near the top of the shaft, and at right angles to it, is fixed a compound bar magnet, each magnet of which is about 18 inches long, one inch broad, and half an inch thick. Near to the bottom of the shaft is fixed another similar compound magnet, with its poles in the opposite direction to the former. In a circle concentric with the shaft, and at an equal distance from each other, are fixed in the base board the lower extremities of four cylindrical bars of soft iron, each of which is enclosed by six coils of copper wire. The coils round each cylinder are separated from each other by intervening cases of oil silk. Each set of extremities of these copper wires is soldered to one stout copper wire ; hence the extremities of the twenty-four coils terminate in eight of these latter wires, four of which proceed from the lower extremities of the coils, and are soldered to the four quadrantal metallic plates, one to each. The other four stout wires proceed from the upper parts of the coils and terminate by proper connections in the circular channels, which are partly filled with mercury. Through the sides of the channels pass four metallic stems, two through each, their inner extremities being in contact with the mercury in their respective channels. The stems of each pair are placed at 90 deg. from each other, and the whole at right angles to the shaft. The right angle which the upper pair forms is on the opposite side of the shaft to that formed by the lower pair. From each stem hangs a metallic wire, reaching obliquely to its respective quadrantal plate on the cross piece, *d*, *d*, which maintains a connection

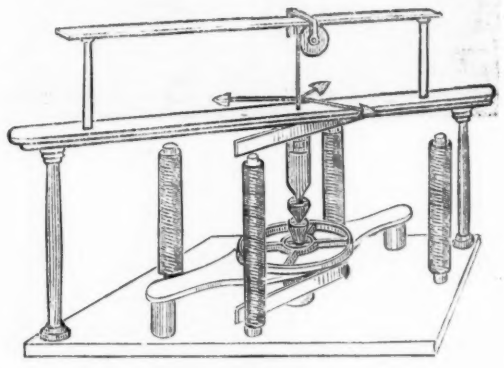


FIG. 17.

between these plates and the mercury in the circular channels, transferring the electric current from one plate to another, and consequently from one coil to another, in their progress of revolution. To prevent the figure being distorted, none of these connecting wires are drawn. The engine is put in motion by the application of two cylindrical voltaic batteries of a single pair each, the metals being placed in two porcelain jars, each of which holds about three pints. These batteries are connected with the conductors of the engine at their terminal cups—one battery at each end of the lowest cross piece. The connections being properly made, the iron cylinders become magnetic in succession, and by the joint attractive and repulsive forces of the permanent magnets, and the temporary magnets, the former, with the shaft and appendages, are pulled and driven round, the action being carried on in the following manner :—Imagine that the pole, N^1, of the permanent magnet is placed directly between the poles, *s* and *n*, of the temporary magnets ; it will by this means be attracted by the former, and at the same time repelled by the latter. Hence it will be urged by both these forces towards the pole, *s*. If now the contrivance be such that the voltaic connections be broken just before the pole, N^1, arrives at *s*, the extremity, *s*, of the iron bar will become neutral ; but the momentum of the machine will carry the pole, N^1, to beyond this neutral point. Now conceive that the pendant wires have been carried from their last quadrantal plates to the next in succession. The cur-

rents by this means have been reversed in all the coils, and a corresponding inversion of polarity has taken place in the vertical iron bars; hence when the pole, N^1, has just passed the first bar, and whilst still in motion by its acquired momentum, it will again be urged on by two other forces, in a similar manner as by the two first. For the extremity having changed its polarity, it will now repel the pole, N^1, and drive it onward, whilst at the same time it will be attracted by the next bar in succession. And in consequence of similar changes of polarity taking place in all the four bars, the pole, N^1, is kept continually revolving. All that has been said respecting the pole, N^1, applies equally to the opposite pole, S^1, of the same magnet. So that by this means the magnet and its appendages are continually urged on by four forces, two attractions and two repulsions; and by considering that the lower magnet, N, S, is by the contrivance also urged on at the same time and in a similar manner, by four other like forces, it will easily be understood that the two magnets, with the shaft to which they are attached, are kept in motion by eight forces, four of which are attractive and four repulsive. Such is the contrivance for keeping the machine in motion. To the upper end of the shaft is attached a vertical spindle, carrying an endless screw near its upper extremity, and revolving as the shaft revolves, in a collar in the upper cross piece. Near to the lower end of this spindle is a fly with three arms, equidistant from each other, and each terminating with a heavy brass crescent. It was originally the fly of a roasting jack. The endless screw works in the teeth of a brass wheel, also a part of the old jack. The arbour of this wheel runs in a frame attached at right angles to the upper cross piece. This engine was constructed in the autumn of 1832, and was exhibited for the first time in London on March 21st, 1833, in a lecture on electro-magnetism, which I delivered at the Western Literary and Scientific Institution. And notwithstanding its then rude appearance, the committee were so highly pleased with its structure and performance, that they expressed a wish to have it brought forward again, and hear it explained as soon as there was another opportunity. I was consequently honoured with an engagement to continue and extend my course of lectures in the following June; and in those lectures my engine again worked well, and excited a great deal of curiosity among the members of the Institution; and I believe was so fortunate as to give general satisfaction. Since that time I have had attached to it contrivances for drawing water, waggons, and carriages on a railway, for sawing wood, pumping water, &c., upon about the same scale as we see pieces of machinery put into motion by the large models of steam engines. But as I saw several parts in which I thought it might be improved, it has long since been lain by, and another one is now building. The old one, however, is still in existence."

From Sturgeon's "Annals of Electricity" April, 1837, Vol. I., p. 250:—

"In the first number of these 'Annals,' I have described an electro-magnetic engine, by means of which pieces of machinery are put in motion. I have now to announce that I have succeeded in propelling a boat, and also a locomotive carriage, by the power of electro-magnetism. The particulars of their construction will be communicated as soon as their present rude state is sufficiently corrected for their appearance in public.—W. S."

Vols. II. and III. of the "Annals" have been searched, but no further notice appears of the electro-magnetic locomotive.

Dr. WERNER SIEMENS'S STANDARD OF LIGHT.*

WE know that the last conference of electricians adopted as the unit of white light, the quantity of light emitted normally by a square centimetre of surface of molten platinum at the temperature of solidification. It is well understood that the platinum must be chemically pure. Even in the midst of the conference the choice of this unit met with some opposition; they objected chiefly that the light emitted by platinum in fusion could not be considered as white compared with solar or electric light; that it was difficult to melt platinum without mixing with it the impurities of carbon, silicium, or other bodies; and, lastly, from a practical point of view, the unit in question could not be obtained in a convenient manner. Dr. Werner Siemens proposed taking, until we could obtain better, as the practical standard of light the little normal lamp constructed by M. V. Hefner-Alteneck,

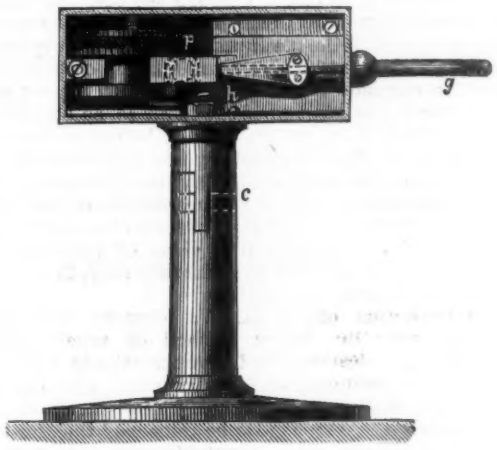


FIG. 1.

which presents considerable advantages over standards of the same kind, although possessing the inconveniences which are inseparable from this kind of unit. English *savants* proposed the quantity of light emitted by a carbon filament (Swan lamp) for a given electrical work. These two standards were rejected by the conference in favour of the standard proposed by M. J. Violle; the first furnished a light too deeply coloured and too subject to variation; the second was no more reliable, the radiation of the carbon filament varying, at the same temperature, with the molecular constitution of the incandescent surface.

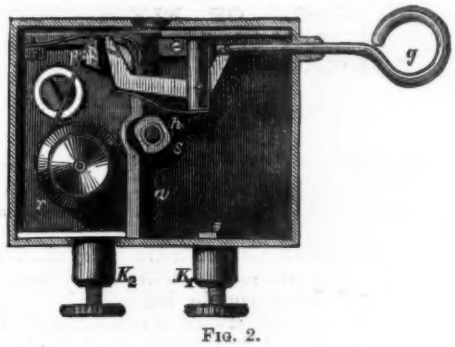


FIG. 2.

After the decision just referred to, Dr. W. Siemens endeavoured to realise the henceforth legal standard in a manner suitable to the exigencies of practice, and constructed the apparatus which we shall now describe.

The principle of the new lamp is most simple, but it must be said that the conditions under which it works are not absolutely identical with those chosen by the conferences, the platinum being taken at its point of fusion, instead of at that of solidification. It is not accurately known whether there is any appreciable difference of temperature between the point of fusion and that of

* *L'Electricité.*

solidification of pure platinum. In either case it would be sufficient, when once this difference was duly proved, to determine the value of the coefficients for reducing the data from the Siemens lamp to those of the legal standard.

Fig. 1 represents a vertical section, and fig. 2 a horizontal section of the apparatus. The latter consists essentially of a small metallic box, of which one side is perforated by a conical aperture (fig. 2), the surface of the smallest circle measuring as exactly as possible one-tenth of a square centimetre. Immediately behind this window, and supported against it, is a sheet of very thin platinum, 5 to 6 millimetres wide; this sheet overlaps on every side the edge of the window. In these conditions an electric current of gradually increasing intensity is passed through the sheet of platinum; the brilliancy of the light emitted by the aperture increases until the platinum melts, and it disappears suddenly. This progressive augmentation of intensity allows the operator to equalise every moment by the photometer the brightness of the lamp to be compared with the standard lamp; an instant before extinction the quantity of light emitted by the window is equal to the tenth of the unit adopted by the conference. A special mechanism placed in the interior of the box, and manipulated by the stud, *g*, has the effect of bringing before the aperture a new sheet of platinum in place of that just melted; experiments may, therefore, be repeated without loss of time.

This apparatus offers, M. W. Siemens says, the advantage over the fusion method of much easier manipulation. Besides, it is comparatively easy to obtain sheet platinum chemically pure, and one is certain that fusion thus produced can introduce no foreign element. It may also be remarked that for the very thin sheet platinum—about 2·02 mm.—the cost of the metal would not be very great.

Comparative measurements made up to the present by M. W. Siemens cannot be relied upon, as the platinum employed was not chemically pure. They show always great regularity in the indications of the apparatus and the manipulation is very convenient. Comparisons made with a normal candle of 40 millimetres height of flame gave the latter a value equal to 0·7 of the legal unit. It is probable that with chemically pure platinum a less elevated figure would have been given.

THE EXPERIMENTAL DEMONSTRATION OF THE INVERSION OF ELECTROMOTIVE FORCE IN IRON-COPPER CONTACTS AT HIGH TEMPERATURES.

NOTE BY M. F. F. LEROUX.

THE French physicist Peltier observed that the junction of two heterogeneous metals is heated or cooled according as it is traversed by a current in one direction or the other.

M. Edm. Becquerel remarked more lately that, if we compare these thermic effects with the direction of current produced by a couple formed of the same metals, in virtue of the difference of temperature of the two joints, this current has generally the effect of cooling the heating junction and of heating the cooling one. In the same year, M. Helmholtz, in his celebrated memoir on the conservation of force, applied these same effects to thermo-dynamics, by supposing that, in thermo-electric couples, the application of heat only produces electromotive forces at the junctions.

Sir William Thomson remarked that such a supposition was in contradiction of the principles of thermo-dynamics, at least for couples subject to inversion, such as the iron-copper couple. He concludes from this that in the mass itself of each of the metals there must exist electromotive forces taking place between the successive layers, by reason of their infinitely small differences of temperature.

In a work published in 1867, to which the Academie was good enough to grant its approbation, I gave, for a great number of common metals, the relative measurements of these electromotive forces. For the sake of brevity, I will call them *the Thomson kind*, those which exist at the junctions being called *the Peltier kind*. I gave also the absolute values of these, between 0° and 25°, deduced from calorimetric observations, the first and, I believe, the only ones which had been made upon this subject. But it has not been possible to make a distinction between the forces of the Thomson kind and those of the Peltier kind, even at ordinary temperatures. In the iron-copper couple, for instance, the inversion might have been produced as well by the change of sign of the electromotive force at the heating junction, as by a suitable variation of electromotive forces of both kinds. In truth, the theory of thermo-electro currents given by Sir William Thomson, or the equivalent theory of M. Tait, lead to the conclusion that there is inversion of electromotive force when the temperature exceeds a certain limit. The length of this note will not allow even an abbreviated exposition of these theories; I know nothing better than to refer to the excellent analysis given by MM. Mascart and Joubert, in their lessons on electricity and magnetism. The only point which I wish to maintain is that they are supported at once upon the principles of thermo-dynamics and upon experimental results which only correspond to a relatively small portion of the scale of temperatures.

These considerations seem to me to render specially interesting the direct determination of the direction of the electromotive force in the iron-copper contact, at temperatures near the fusing point of the second of these metals. The experimental process which I employed is that of the estimation of the direction from the Peltier effect, produced by a current of known direction. Given two iron-copper contacts, traversed in opposite directions by the same current, the direction was taken from the difference of their temperatures. This difference is sensibly proportional to the quantity of heat absorbed and disengaged at the two junctions, which may be estimated by the product of the intensity of the current by the unknown electromotive force. This was certainly only a small fraction of a volt; it was therefore necessary to have a great intensity of current. That which I have been able to realise was a mean of 350 ampères, and in these conditions the thermic effect at the junctions should not attain a hundredth of a calorie per second.

There remained to be found a thermometric, or rather thermoscopic mean, compatible with the considerable elevation of temperature. I was able to utilise, for this purpose, the rapid variation of the function of the temperature which is expressed by the intensity of the light emitted by incandescent bodies. At about 1,000° the two iron-copper junctions presented differences of brilliancy sufficiently marked to be visible to the eye. I have been able also to show the same differences by photographic impressions upon gelatino-bromide plates.

The passage of the current also heats the conductors according to Joule's law, that is to say in inverse ratio to their section and proportionally to the square of its intensity. In order that this effect should not interfere with the phenomena, it was necessary first of all that the section should be sufficient to render the heating scarcely sensible, and also that each metal should have exactly the same section throughout its length without which this heating would be felt unequally upon the two branches of the couple. In every case we were assured that the reversal of the current changed the direction of the difference of brilliancy.

I employed several iron-copper circuits, in which the iron was a bar about 0·25 m. in length and about 0·015 m. to 0·018 m. square; this bar of iron was bent in the form of a horse-shoe; in the extremities were imbedded rods of copper about 0·009 m. in diameter. The whole was enclosed in a muffle heated by gas and having an aperture for observation. In one of the models experimented upon which I had the honour to place before the Academie, I covered the faces with plates of platinum

of which I observed the incandescence, in order to prevent the radiation being modified by the layer of oxide which is formed upon the surface of the iron.

The determinations which I made in several series of experiments, with some variations in the installation of the apparatus, and, as an extra precaution, by the assistance of witnesses having no preconceived idea upon the direction of the phenomena, led me to conclude that, towards the temperature of 1,000°, a current passing from copper to iron heats the junction, whilst it cools it at the ordinary temperature. It is thus experimentally proved, for the first time, the change of sign of the function of temperature which represents the electromotive force of contact between two metals, and there is room to suppose that the notification of this fact may be useful not only for the theory of thermo-electricity, but also for that of certain chemical phenomena.

ON THE ELECTRIC LIGHT.*

By ALFRED RICHARD SENNETT, A.M.I.C.E.

IT is the purport of the author briefly to explain in what electric lighting consists, the relation which it bears to other methods of illumination, and to describe some of the apparatus employed in its production and utilisation. Very different figures have been assigned to the temperature of the poles of the electric arc: thus Prof. Rosetti, after a long series of experiments, gives + 3,200° to 2,500° Centigrade; Prof. Dewar + 6,000° Centigrade; Prof. Becquerel + 2,000° Centigrade. Now, taking the lowest of these, and assuming the law of Becquerel to hold good for high temperatures, each unit of area of the electrode would emit a light 191,000,000 times as intense as that of a body at 916° Centigrade (melting point of silver). The most simple method of conversion is by chemical action, exemplified in galvanic batteries, the efficiency of which, as will be seen by comparing the energy obtained by the combination of zinc in various cells by Julius Thomsen, with the energy of combination of a given weight of zinc with oxygen, is very high; but the relatively high price of the fuel consumed, and the fact that the heat procurable from a given weight of zinc is only about one-seventh that obtainable from coal, prohibits its use. Now since loss is always consequent upon the conversion of one form of energy into another, it should be the aim of the engineer both to reduce the number of conversions and to diminish each to a minimum, so that the highest possible per-

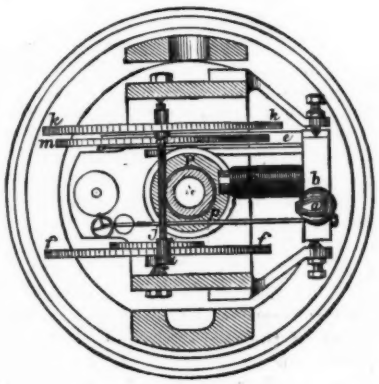


FIG. 4.

centage of the original store of energy may be obtained at the focus of illumination. Fig. 1 shows the fall of potential when a steam-engine is employed. The fall is due to the following efficiencies:—Steam-engine, 11 per cent.; gearing, 95 per cent.; dynamo-electric generator, 80 per cent.; cables, 93 per cent.; and carbons, 94·4 per cent. The ordinate, G, H, represents the potential energy of coal (that is, the energy with which the carbon wishes to unite with the oxygen of the air.) In this case let G, H represent 1 lb. of coal = 800·0 cent.-units of heat × 1,390 foot-lbs. = 333·6 H.P. per minute = 5·56 H.P. per hour. Under the conditions shown the energy expended in the arc will be 0·4 H.P., which will yield a light (in an arc of great power) equal to about 800 standard candles for one hour. If the whole energy had been transmitted to the generator, a light equivalent to about 7,420 candles would have been produced, whilst if the whole fall of potential had taken place in the arc, a light of the intensity of about 11,120 candles for an hour would have been the result.

* Abstract of a paper read at a supplementary meeting of the Institution of Civil Engineers, May, 1884.

The number of forms of mechanism which have been devised for the purpose of effecting the necessary feed of the carbons is very great, and it is extremely interesting to trace their development towards perfection. The author will, however, explain only that apparatus appertaining to electric lighting, with which he is connected. Diagrams showing the disposition of the parts of the lamps and the method of connection are given in figs. 2, 3, 4, 5 and 6.

In order to obtain delicacy in the feed, most lamps hitherto

FIG. 1.

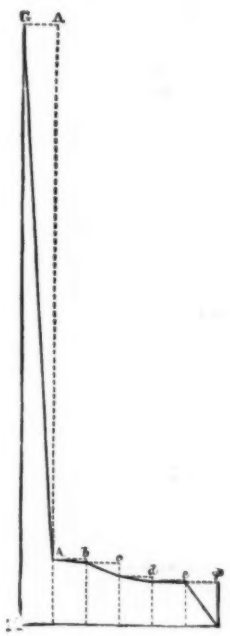
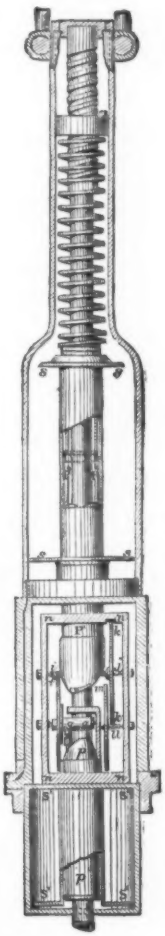


FIG. 2.



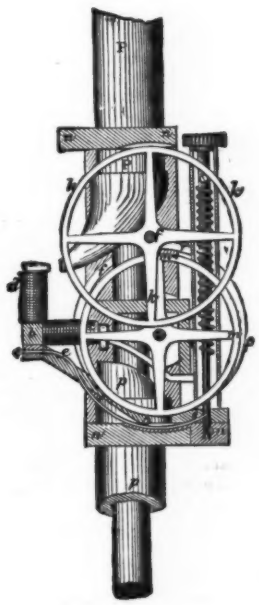


FIG. 3.

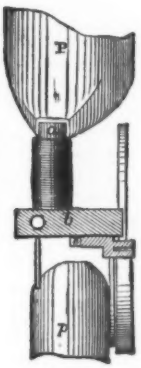


FIG. 5.

have been provided with long trains of wheel-work, with the object of lessening as much as possible the work done by the governing-device, and of reducing a comparatively coarse feed of the governing-device to a very fine one of the carbons themselves. The feed is generally governed by the movement of heavy armatures or solenoid cores. Two great disadvantages in this method of governing are: first, that the moment of inertia of both the train and the armatures is too great to allow the system to respond to very slight deviations from the required conditions; and secondly, that as the force acting between the magnet and its armature varies as the square of the distance through which it acts, the power of the governing-device varies greatly with its

position. Consequently, when the governing-device is actuated by any deviation from the required conditions of the system, it can never cease to act exactly when the required condition has been regained, but must continue to act until a deviation has been produced in the opposite direction. For the governing-device the author employs a very light and delicately suspended or balanced electro-magnet, or solenoid, working under the influence of controlling electro-magnets or solenoids. In figs. 2, 3, 4, 5 and 6, *a*, *b*, *c*, represent the delicately balanced electro-magnet, and to which for brevity the author has given the name "reaction or reciprocal armature." The poles which control the action of this reciprocal armature are formed by the prolongation of the plungers, *p*, *p*, and P′, P′, of the solenoids.

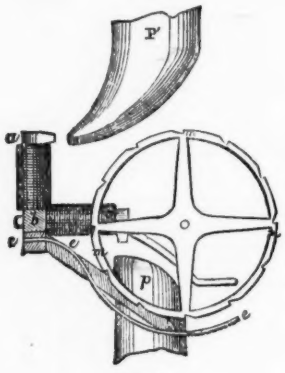


FIG. 6.

The reciprocal armature has not a continuous paramagnetic core, but consists of two cores separated by diamagnetic material. The core, *b*, *c*, has wound upon it a wire forming a continuation of the wire upon the solenoid, s′, s′, s′, s′, which is so connected as to form a shunt or derived circuit to the arc; that is, the current flowing in the circuit thus formed does not pass through the arc. The arrangement is very similar to the by-pass upon an ordinary gas-main. The wire coiled upon *a*, *b*, virtually forms part of the main circuit, namely, the circuit through both the arc and the by-pass, although for constructional reasons it is made to form a derived circuit to the solenoid, *s*, *s*, *s*, *s*, in order that a much finer wire may be employed. Attached to the diamagnetic portion of the armature is the brake-spring, *e*, *e*, *e*. The plungers, *p*, *p*, and P′, P′, project from the top and bottom of the gearing frame, and play within the solenoids, *s*, *s*, *s*, *s*, s′, s′, s′, s′. Consequent upon the strength and sensibility of the reciprocal armature the author has been enabled to employ a very short train; it consists of the first wheel, *f*, *f*, connected to the pinion, *g*, *g*, which gears with the rack through the intervention of a ratchet wheel, in order that the rack may be raised without the necessity of revolving the train backwards. This first wheel gears with the pinion, *i*, keyed to the arbor, *j*, upon which is mounted the wheel, *k*, *k*, gearing with the small pinion, *l*, *l*. This latter carries the aluminium brake-wheel, *m*, *m*, the total weight of which together with the pinion is about $\frac{1}{16}$ oz.

The action of the lamp is as follows:—when no current is flowing the gearing frame, *n*, *n*, *n*, *n*, rests nearly upon the bottom of the framing of the lamp, in which position the carbons are in contact. Upon a current passing through the lamp the plunger, P, P, is drawn up into the solenoid, *s*, *s*, *s*, *s*, and by this motion the arc is formed; the current now flows through *s*, *s*, *s*, *s*, *a*, *b*, and the arc, and by the other route through s′, s′, s′, s′, and *c*, *d*. The directions of winding are such that repulsion takes place at *a*, and attraction at *c*, and these may be made to just balance each other with a given difference of potentials between the electrodes. In order, however, that the lamp may be adjusted to maintain any length of arc at will, the attraction at *c* is made to be slightly in excess of the repulsion at *a*, in order that a certain amount of twist may be imparted to the system, the amount of which, however, may be regulated by the tension of an adjusting spring.

By this means the author has been enabled to employ a governing-device, whose power and sensibility are independent of its position in relation to the controlling poles, and thus the objections above referred to have been eliminated, the motion of the feed-mechanism being arrested immediately the required conditions are fulfilled. In order to reduce to a minimum the electrical energy necessary to perform the mechanical operations of the lamp, the solenoid, *s*, *s*, *s*, *s*, is assisted in its work by a suspension spring, or by being partially balanced, and this increases the sensibility of the lamp, since it causes it to respond immediately to any sudden lengthening of the arc by the bodily movement of the gearing-frame and train.

It is obvious, in order to make the efficiency of an arc lamp as high as possible, that care should be taken, first, that the resistance introduced into the main circuit be as small as possible, and secondly, that the smallest possible amount of energy be allowed to flow through the shunt or by-pass circuit. The resistance of this latter then should be as great as possible, and by the employment of the reciprocal armature, the author has been able to raise this resistance to 2,000 ohms. On account of the resistance of the shunt, or by-pass being so great, it is almost impossible to burn it, especially if the generating plant be provided with suitable regulating appliances. The burning of the shunts of differential lamps has hitherto been a source of some trouble.

A peculiarity of this lamp consists in the fact that it will continue to feed even though the shunt be burned. In order that it may do this, a little lever is generally attached to the cross-bar, *b*, *b* (figs. 2, 3, 4 and 5), of the reciprocal armature, and projects in the opposite direction to the brake-spring, *e*, *e*, *e*. Projecting from the rigid frame of the lamp is a stop, so placed in relation to this lever, that when the gearing frame, *n*, *n*, *n*, *n*, descends, it engages with the lever and thus removes the brake. The action of the lamp after the burning of the shunt is easily seen. The gearing-frame, when a normal strength of current is flowing, is held up against the top of the rigid frame. As, however, the length of the arc becomes greater, and its resistance in consequence increases, the gearing-frame slowly descends, and after a time the lever engages with the stop, and the brake being thereby removed, the mechanism feeds, but ceases to do so as the strength of current increases, and the gearing-frame gradually rises. The rack instead of being solid is formed of a drawn brass tube, and the arbors and the fulcrum of the reciprocal armature instead of being supported in bearings are carried upon hardened steel points. The employment of the latter greatly increases the life of the motion.

Before considering the other apparatus employed in electric lighting, it will be interesting to glance at the relation which lighting by the electric arc bears to other methods of illumination. As regards heating, the effect, then, of the electric light in an open space may be said to be nil. In a confined space, a rise in the temperature of the air will take place proportional to the energy expended in the arc. Since, however, the amount of light produced per unit of heat so expended is so much greater than by other means, the air will receive a much smaller increment of heat by this than by other methods of illumination. For the purpose of comparison, imagine a chamber, say 50 feet square by 20 feet high, from which no loss of heat can take place, to be illuminated for 10 hours by a light equal to that given by 4,000 standard candles, the light being produced respectively by the electric arc, by incandescence electric lamps, by gas, and by candles. At the end of the 10 hours the temperature of the atmosphere of the chamber would be raised:—

	Centigrade. °	Fahrenheit. °
By the electric arc	0·706	1·27
By incandescence electric lamps	7·0	12·6
By gas	78·4	141·0
By candles	190·0	342·0

In other words, if, at the commencement of the 10 hours, the atmosphere of the chamber had been at the ordinary temperature (16° Centigrade, or 60°·8 Fahrenheit), then at the expiration of the 10 hours it would have been raised:—

	Centigrade. °	Fahrenheit. °		Centigrade. °	Fahrenheit. °
By the electric arc from	16	or 60·9	to	16·7	or 62·1
By incandescence electric lamps	16	„ 60·9	„	23	„ 72·9
By gas	16	„ 60·9	„	98·4	„ 201·8
By candles	16	„ 60·9	„	206	„ 402·8

In order to facilitate comparison as regards the products of combustion, the author has drawn up the following Table, showing the carbonic anhydride, &c., produced per hour from an equal amount of light derived from the sources mentioned:—

PRODUCTS OF COMBUSTION FROM VARIOUS ILLUMINANTS.

——	1 CO_2.	2 N_2O_4.	3 S.	4 H_2SO_4	5 H_2O.	Remarks.
	Grains.	Grains.	Grains.	Grains.	Grains.	
Electric Arc	6,413	8	trace	...	none	Traces of cyanogen
Gas No. 1	852,929 = 122 lbs.	trace	333*	1,019	286,848 = 41 lbs.	Ordinary burner. Average gas.
Gas No. 2	339,889 = 48½ lbs.	trace	125*	382	107,568 = 15·3 lbs.	Siemens burner.
Paraffin oil	573,040 = 73 lbs.	none	trace	trace	2,683,000 = 383 lbs.	...
Candles No. 1	1,410,860 = 201·5 lbs	none	none	none	5,760,000 = 823 lbs.	Sperm.
Candles No. 2	1,141,514 = 163 lbs.	none	none	none	6,336,000 = 905 lbs.	Paraffin.

It will be observed that no absolute value can be given to express the relation between the electric arc and other methods of illumination as regards their effect upon the purity of the atmosphere, since the efficiency of the arc (in respect of illumination) varies with the amount of electrical energy passing between the electrodes; whilst the amount of light obtained from the combustion of a given volume of gas depends upon its quality, upon the burner or manner in which the chemical combi-

* Combines with O to form SO_2, and this, combining with O and H_2O, forms H_2SO_4.

nation is accomplished, and upon the temperature at which the chemical combination is effected.

Referring again to the hypothetical chamber, it would have been necessary, in order to reduce the amount of defedation of the air as regards CO_2 to the standard of that of the air of a manufacturing town, to have changed the whole of the air in the chamber during the 10 hours, as given in the second column. The first column showing the relative amounts of CO_2.

FIG. 7.

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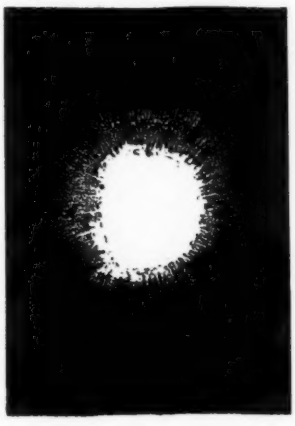

	Relative amounts of CO_2.	Times.
For the electric light	1	3¼
„ gas (No. 1 in Table) ordinary burner and average gas...	133	500
„ gas (No. 2 in Table) Siemens burner	53	200
„ paraffin oil	80	300
„ candles (No. 1 in Table) sperm ...	220	830
„ candles (No. 2 in Table) paraffin...	178	670

The actinic effect of the electric arc depends on three factors, one of which is constant and the other two variable. The constant factor depends on the current, since it varies with the area of the crater; the other variables depend on the kind of carbon employed for the electrodes and upon the length of the arc.

First, a very long arc should be employed.

Secondly, a line normal to the plane of the specimen should form an angle of from 30° to 50° with the axis of the carbons, if these are placed vertically and the axis of one carbon is coincident with the axis of the other. He has found it more convenient, however, in many cases to arrange the carbons as in military and naval lighting, by which the rays of greater refrangibility proceeding directly from the crater are utilised. The observance of these conditions is obviously of great importance, when it is required to obtain the maximum speed from a given arc in the printing of photographic transfers, &c. Upon plotting a number of results it was found that the curve of actinic effect was practically coincident (especially for moderate powers) with that of illuminating power.

For general illumination and industrial purposes the positive electrode is usually placed above the negative, its axis being vertical, and forming a prolongation of the axis of the negative; but for special purposes it is sometimes advantageous otherwise to dispose the electrodes. In search lights, for example, the upper carbon is generally placed in the rear of the lower, so as to expose the crater toward the front. For lighting with vertical carbons the author prefers to employ an upper carbon of about 3 or 4 millimetres greater diameter than the lower.

With regard to the fluctuations in the intensity of the light emitted by the electric arc, with alternating currents, and with uni-directional currents of feeble strength and great electromotive force, the arc is in incessant vibration and motion around the points in its endeavour to pass by the path of least resistance, and in this they present a marked contrast to the fixity of the light emitted from arcs produced by currents of great strength and of small electromotive force working with a moderate length of arc. With a long arc or feeble current the colour of the light is less pure, being more violet or purple as a greater amount is derived from the arc proper and less from the incandescent electrodes. In addition to the greater stability of currents of low electromotive force, the light emitted by arcs produced by them is less influenced by any momentary vacillations of the current or movement of the arc; since with feeble currents, the electrodes become heated only in the immediate vicinity of the points where the arc leaves and enters them, whilst with powerful currents a comparatively large surface of the electrodes becomes incandescent. Figs. 8, 9, 10, 11, and 12 serve to give a general idea of the appearance of the arc, with various dispositions of the electrodes. In each case the same (powerful) current was employed.

FIG. 11.

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FIG. 8.

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FIG. 9.

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FIG. 10.

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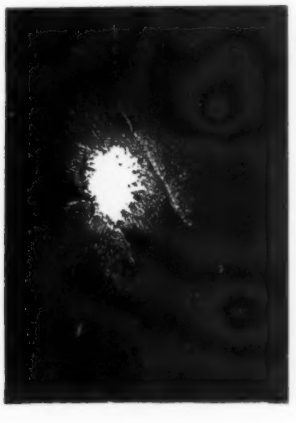


Fig. 7 is that of an arc of moderate length.

Fig. 8 represents an arc of the same power, slightly shorter, and with an upper carbon having a diameter 3 or 4 millimetres in excess of the lower one.

In fig. 9 the front or crater side of an arc having the upper (positive) carbon about half its diameter is in the rear of the lower as hereinafter explained.

In fig. 10 the same disposition is seen from the side (= 90° from the preceding view).

Fig. 11 is that of an arc set very short.

It will be observed (more especially in fig. 11), how very much higher in temperature the positive carbon is than the negative.

For ordinary industrial purposes it is generally required to illuminate uniformly a horizontal plane at a certain distance below the arc. Reference to the diagrams (figs. 7 to 11) will show that this is rather imperfectly accomplished by the unaided arc, since the lower or negative electrode casts a circular shadow on the

horizontal plane, the area of such shadow increasing with the square of the height of the arc, which should always be great to obtain economy and uniformity in lighting.

The loss of light by absorption in various diffusing media has not been thoroughly investigated, and the results which have been obtained are very discordant. In measuring directly by first taking a reading of the naked light and then interposing the substance whose absorption is required to be ascertained, and afterwards taking another reading, the result is as much an indication of the dispersive and reflective effect of that particular substance as of the light absorbed, since the intensity of the light which originally fell upon the screen of the photometer is, by the use of the diffusing medium, diminished by being caused to occupy a larger area, and also by many of the waves being turned back by reflection. The loss will, therefore, vary with—

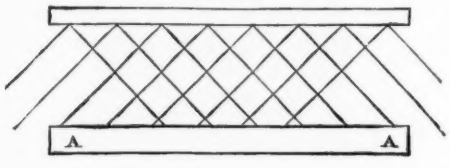
1st. The distance of the specimen from the screen of the photometer.

2nd. The size of the specimen or that of the aperture through which the light is admitted to it.

3rd. Its reflective effect.

The author proved the accuracy of the first assumption by taking separate sets of readings, one set at a great and others at smaller distances from the light. The second assumption was too obvious to need verification. Figs. 12 and 13 will show this.

FIG. 12.



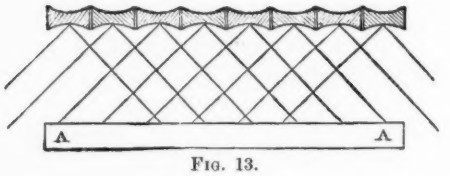


FIG. 13.

Imagine the specimen to be composed of an infinite number of bi-concave lenses, then it is evident that the amount of light falling on the given area, A, will vary with the first and second conditions.

The comparison of the efficiencies of the different modes of illumination is an interesting and instructive consideration, but it is one beset with considerable difficulty, as scarcely any complete set of efficiencies has been taken. As a way of effecting a comparison it has been suggested to take a number of readings at different angles, and to consider the average as the candle-power of the light. This meets the difficulty to a certain extent, and is the method upon which the author has based his calculations. The commercial efficiency may, however be very different.

The following table is not intended to be a comparison of the costs, but only of the efficiency of transformation; the cost-efficiency depends not only on the efficiency of transformation, but also on the economy of the means of transformation :—

TABLE SHOWING CANDLE-POWER PRODUCED PER HOUR BY 1 lb. OF COAL TRANSFORMED IN DIFFERENT WAYS INTO LIGHT.

No.	Method of Transformation.	Gas Produced.	Coal Required per H.P. Effective per Hour.	Candles per 5 Cubic Feet per Hour.	Gas per Effective H.P. per Hour.	H.P. given to Dynamo.	Electrical H.P. at Terminals of Lamps.	Candle-power per Effective H.P. at Terminals.	Candle-power per Hour obtained.	Relative amount of Light from each, taking ordinary Gas-burner as 1.
		C. Ft.			C. Ft.					
1	Coal-gas	4·4	..	12	..	..	..	..	10·6	1·0
2	Coal-gas, gas-engine, dynamo and arc lamp	4·4	..	..	30	0·15	0·11	1,200	126·6	11·9
3	Coal-gas, gas-engine, dynamo and incandescence lamps	4·4	..	..	30	0·15	0·11	200	21·1	2·0
4	Dowson gas, gas-engine, dynamo and arc lamp	83·3	..	..	125	0·67	0·48	1,200	576·0	54·3
5	Dowson gas, gas-engine, dynamo and incandescence lamps	83·3	..	..	125	0·67	0·48	200	96·0	9·0
6	Steam-engine, dynamo and arc lamp	..	2¼ lbs. to 4 lbs.	..	..	0·40 to 0·25	0·29 to 0·18	1,200	348·0 to 216·0	32·8 to 20·4
7	Steam-engine, dynamo and incandescence lamps	..	2¼ lbs. to 4 lbs.	..	..	0·40 to 0·25	0·29 to 0·18	200	58·0 to 36·0	5·5 to 3·4
8	Siemens burner, ordinary gas	4·4	..	30	..	..	..	..	27·0	2·5

It should be remembered in reviewing the above table, that on account of its showing the light produced by 1 lb. of coal, that the by-products resulting from the production of ordinary coal-gas cannot be considered. If it had been a consideration of the cost efficiencies instead of light, the efficiencies of Nos. 1, 2, 3 and 8 would have been much higher, as in this case the value of the by-products might have been taken into account.

Data assumed, efficiency of dynamo 80 per cent.
" efficiency of cables . 90 "
" good steam-engine . 2¼ lbs. of coal per effective H.P. per hour.
" average " . 4 lbs. of coal per effective H.P. per hour.

When the arc is produced in air (which is always the case when employed for industrial purposes) the carbon electrodes are gradually consumed in the ratio of about one part of the negative to two parts of the positive.

Purity, hardness, and homogeneity are the chief desiderata in a good carbon. Out of seven specimens of carbon of well-known make the author found the most light to be produced by the one containing the least amount of impurities. The following shows the amount of ash in each :—

	Per Cent.
S	12·45
E, C, C, V	5·35
G, *y*	3·72
B	3·50
C, C, C, *d*	2·80
C	2·84
G, *n* (original Gaudoin) ...	1·80

The purest carbon, and that giving the highest efficiency, was the last, which was made by Mr. Gaudoin. The others are at present in the market, and the author abstains from giving the names. The redness of the ashes afford an approximate indication of the amount of iron contained in each specimen. All attempts to increase the illuminating power of the arc, by the introduction of various materials during the manufacture of the carbons, have failed, as the decomposition of such materials produces gases which, at the high temperature of the arc, become conductors. Several methods of preventing the wasting away of the carbons have been patented.

The importance of purity and density in the carbons cannot be too strongly pointed out. No mechanism, however delicate, can be devised to produce a steady light if imperfect carbons be employed.

THE ALTERNATE-CURRENT MACHINE AS A MOTOR.*

By Prof. W. GRYLLS ADAMS, F.R.S., President.

IN July last, whilst engaged in testing the efficiency of alternate-current magneto machines at the South Foreland, for the Elder Brethren of the Trinity House, it was suggested to me by Dr. Hopkinson to try the experiment which was shown by him to be possible in his lecture before the Institution of Civil Engineers last year, viz., the running of two alternate-current magneto machines together, without clutching them on the same axis, in order to supply current to an external circuit.

The machines now being tested at the South Foreland are three De Meritens alternate-current magneto machines of the largest size made by him, having 60 permanent magnets, arranged in five rings of 12 magnets and 24 coils on each ring of the revolving armature. Each coil consists of four layers of wire, and is 27 millimètres deep and about 100 millimètres wide. The 120 coils when arranged in parallel circuit for lighthouse work, have a resistance of about one-twentieth of an ohm. The internal resistances of the three machines are ·044 ohms, ·049 ohms, and ·056 ohms.

The five rings of coils on each of the machines are connected in parallel circuit when all the brushes are down, but the collectors and brushes on each machine are made in three sections, so that it is possible to employ one ring only of magnets and coils, or two rings only, or the remaining three rings, or the whole five rings together, by bringing the respective brushes in contact with their own collectors, which are insulated from one another by ebonite rings or flanges on the ebonite axis which insulates the collectors from the axis of the machine. The diameter of the armature carrying the revolving coils is 2 feet 6 inches, or 760 millimètres, and the driving pulley is about 16 inches, or 400 millimètres, in diameter.

When revolving at the normal speed, 600 revolutions per minute, the magneto machines have been found to work with

* A brief abstract of this paper, which was read before the Society of Telegraph Engineers and Electricians, was published in the ELECTRICAL REVIEW for November 22nd.

very great steadiness and with great efficiency. The electromotive force is about 75 volts and $\frac{2\pi\gamma}{T} = \cdot 3$ ohms nearly.

When running with the circuit open, a very considerable amount of work is spent on the friction and internal work within the machine, but on closing the circuit this is greatly diminished, and the output of the machines, or the electrical energy in the external circuit, exceeds the *additional* work done to produce it. Thus a single machine absorbs 4·2 horse power when running at 600 revolutions with the circuit open, yet only absorbs 10·4 horse-power with the circuit closed with one arc lamp in circuit, when it yields in electrical energy 6,000 watts, or 8 horse-power, in the external circuit. These watts are obtained by multiplying the average electromotive force, as given by Cardew's voltmeter, by the average current as given by Siemens' electro-dynamometer. This product will give a result which, according to Dr. J. Hopkinson's calculations, is above the true value.

The electromotive force was also determined by a quadrant electrometer, by joining the needle to one pair of quadrants, when the expression for the electromotive force becomes $(v - v_1)^2 = E^2 = \frac{2d}{k}$, where d is the deflection, and k the constant of the electrometer.

The method of determining the work done in the arc by joining the pairs of quadrants of the electrometer to the two ends of a known resistance placed in the circuit, according to the formula

$$d_1 = k(v_1 - v_2)\left(v - \frac{v_1 + v_2}{2}\right) = k\,c\,r\left(v - \frac{v_1 + v_2}{2}\right),$$

was also tried, but the introduction of even a small resistance, r, materially altered the electromotive force and also the current in the circuit, and the method was not sufficiently sensitive. Thus, when the deflection by the first method, $\frac{k}{2}(v - v_1)^2$, was 120 divisions of the scale for an electromotive force of 57 volts, the deflection by the second method was only about 30 divisions when r was about one-fifteenth of an ohm. The addition of this resistance considerably increased the electromotive force, and diminished the current in the circuit.

At the South Foreland the leads from the machines to the arc lamps in the experimental tower have a resistance of ·066 of an ohm, and when two machines were clutched together and working in series, so as to supply two arcs in series, the yield of electrical energy per second was about 10,200 watts in the external circuit; whereas, when working in parallel circuits through the same leads to one arc lamp, the yield was only about 8,600 watts in the external circuit.

To test whether alternate-current machines would work in harmony without being rigidly made fast on the same axis, two machines which are usually clutched together were set running, being joined in parallel circuit, and when they had attained their usual speed of about 600 revolutions a minute they were unclutched, and each was driven only by its own belt. The two machines continued to run together very steadily, mutually governing one another; the electromotive force remained steady at 75 volts on open circuit, the same as the electromotive force of one of the machines which had been previously tested.

The machines were not quite equal in efficiency, for before this experiment one of the single machines had given a current of 135 ampères, and the other 165 ampères, with electromotive force of 37 volts, at the normal speed of 600 revolutions; now on closing the circuit from the two machines through the arc, the electromotive force became steady at 40 volts, and there was a current of 221 ampères, giving 8,800 watts in the external circuit, and the machines continued to run as steadily as if they had been clutched.

The lamp was now put out of the circuit and the machines short-circuited upon one another, without the slightest danger to the machines, owing to their high coefficient of self-induction. The belt was then thrown off one machine, when it continued to run at the same uniform speed, being driven as a motor by the electric current from the other single machine, and the electromotive force was equal to the electromotive force of the machine on open circuit.

An attempt was now made to introduce an arc into the circuit, but the motor immediately began to lose its speed and the arc became fitful with long beats, as in two musical instruments getting out of harmony, the beats increasing as the speed fell and the machine stopped.

A third machine similar to the others, but not placed on the same axis and having no mechanical connection with them, was also driven as a motor by one of the other two machines.

These experiments were repeated, and some other interesting experiments made, on October 18th, when Dr. J. Hopkinson went with me to the South Foreland.

Two machines were started together, but independently, each being driven by its own belt, and they increased their speed in harmony, always going together until they reached their normal speed, when the electromotive force rose to 80 volts. The belt was now thrown off one of the machines, when the electromotive force at the terminals of the driving machine remained at 80 volts. A strap was placed round the pulley of the motor machine, and a weight of 14 lbs. was hung on the strap; the machines continued to run together, but the electromotive force oscillated from 80 to 78 volts as the weight rose and fell with the pull on the strap, being not heavy enough to give a steady pull. Thus one machine was being driven as a motor by another equal machine, and was doing work which was measured by the friction brake. The pulley was 16 inches in diameter, and the speed 600 revolutions, giving 35,200 foot-pounds per minute, or more than one horse-power.

On putting on 28 lbs. on the pulley of the motor, the electromotive force was reduced from 80 volts to 78 volts, and remained steady, and the machines still ran together. On putting 42 lbs. on the brake on the pulley of the motor, the electromotive force was reduced to 76 volts, and then 56 lbs. was put on, when the motor continued to run at the same rate as the generator, and the electromotive force was steady at 74 volts.

On account of the heating of the extemporised brake-strap, it was not thought advisable to continue the experiments by adding heavier weights, although there seemed to be every probability that the machines would continue to run together at the same speed, the one as generator and the other as motor and doing work. The above experiments show that the work done on the brake was 140,000 foot-pounds per minute, or more than four horse-power.

In another experiment the three machines were started together, and run up to their usual speed of 600 revolutions per minute, each machine being driven by its own belt. The belts were then thrown off two of the machines, and they were driven as motors by the current from the third machine, the electromotive force at the terminals of the third machine being the same as when the three were running together in parallel circuit.

On November 10th, I again made further experiments with the three De Meritens magneto machines, and made measurements of the light given by the arc worked from the machines separately and combined in parallel circuit.

The resistance of the leads from the engine-room to the photometric gallery in which the measurements were made was ·032 ohms (cold), and the leads were heated considerably, and where exposed became quite warm to the touch when carrying the current from two machines or from the three machines.

One machine alone gave a current of 175 ampères, with an electromotive force of 40 volts at the machine terminals, and an electromotive force of 33 volts at the extremities of the arc, giving 5,775 watts expended in the arc and 1,225 watts expended on the leads.

Two machines worked well together, being driven independently, and gave an average current of about 275 ampères, with an electromotive force of 47·5 volts at the machine terminals, and an electromotive force of 35·5 volts at the extremities of the arc, giving 9,750 watts expended in the arc and 3,300 watts expended on the leads.

Another experiment with two machines gave an average current of 278 ampères, with an electromotive force of 48 volts at the machine terminals, and an electromotive force of 36 volts at the extremities of the arc, giving 10,000 watts as the energy per second expended in the arc.

These experiments give for (1) One machine—7,000 watts (electrical energy in external circuit); 1,715 watts (electrical energy in internal circuit); giving 8,715 watts as the total electrical energy per second.

The power absorbed, as shown by indicator diagrams, during this running was 13·8 horse-power, or 10,295 watts, giving an electrical efficiency of 84 per cent.

(2) Two machines—13,300 watts in the external circuit; 1,800 watts in internal heating of coils; giving 15,130 watts as the total electrical energy per second.

The power absorbed was 28·53 horse-power, or 21,280 watts, giving an electrical efficiency of 71 per cent.

The electromotive force and current remained as steady as when the two machines had been mechanically connected together by clutches, completely proving that with equal machines such mechanical connections are entirely unnecessary.

This we had also found to be the case in the experiments of October 18th, when experimenting with two machines, and also with the three machines running on the same parallel circuit. The third machine has no mechanical connection with the other two machines, except through the belting, being driven from the same countershaft. When run together, the three machines gave a steady current of 300 ampères through an arc with an electromotive force of 49 volts at the machine terminals, and of 37 volts at the extremities of the arc, giving 11,100 watts expended in the arc.

On account of the high resistance and consequent heating of parts of the lamp, and the irregularity of burning of the 40 millimetre carbons employed, the current from the three machines was only about 25 to 30 amperes greater than the current from the two machines.

The heating of the lamps was however greatly diminished by means of a by-pass, suggested by Dr. Hopkinson, from the conducting leads to the lower carbon, whereby a very considerable portion of the current was shunted past the lamp.

In the experiments on November 10th, with the three machines driven independently in parallel circuit, there was considerable variation in the mean electromotive force and in the mean current. The irregularity was due to the very unequal burning of the carbons, which was noticed at the time of the experiments, and not to any irregularity in the working of the three machines; for as the electromotive force increased the current diminished, and there was comparatively little variation in the rate of work done in the arc. In one set of experiments the electromotive force varied from 42 to 32 volts, and the current from 270 to 310

ampères, yet the product remained much more nearly constant, and the average was about 11,000 watts. In another set the electromotive force varied from 41 to 37 volts, and the current from 290 to 316 ampéres, giving an average of 11,600 watts in the arc.

The belt was now thrown off the third machine, which still continued at the same uniform speed, being driven as a motor by the current from the other two machines, with the arc still in the external circuit. Thus, of three alternate-current machines arranged in parallel circuit to supply current to an external circuit, one may be run as a motor by the current from the other two, which will continue to supply an arc in the external circuit. The electromotive force at the extremities of the arc and the current through the arc were measured, and experienced wider variations than in the last experiment with three machines parallel, but the power in the arc remained very constant at about 12,000 watts, rather greater than when the three machines were driven directly from the engine. The arc also was observed to be steadier when the third machine was being driven as a motor, as though the motor acted as a governor on the circuit. The electromotive force at the extremities of the arc varied from 52 to 41 volts, with occasional readings outside these limits, and the current varied from 240 to 285 amperes, the electromotive force rising when the current diminished in such a way that the product remained very nearly constant. It would seem from these experiments that the work done in the arc with two machines combined in parallel circuit, without the third machine in the circuit at all, was considerably less than the work done when the two machines were supplying the arc, and at the same time driving the third machine as a motor.

Not only so, but when the machines were all three driven directly from the engine, the work done in the arc was rather less than the work done when the two machines were supplying the arc and at the same time driving the third machine as a motor. These remarkable results are also borne out by the photometric results obtained during these experiments.

With the kind assistance of Mr. Longford and two of my students, Messrs. Anderson and Wordingham, I was able to measure the current, the electromotive force at the terminals of the machine and at the terminals of the arc, as well as the candle-power throughout the experiments. The photometer employed was Dr. Hopkinson's dispersion photometer, in combination with a star disc and a paraffin lamp with a Methven slit which had been standardised, and gave an illumination of 1 candle at the distance of 1 foot. Ruby glass and ammonia sulphate of copper solution placed before the eye were employed to compare the intensities of red and blue in the two sources of light. By the Hopkinson photometer an illuminating power of 16,000 candles was reduced to six candles within a distance of 100 inches from the arc. The illuminating power given by the arc fed by the current from one machine was measured at a distance of 50 inches from the arc, and was found to be, with red light, 8,000 times, and with blue light, 16,000 times the light of one candle.

At the same distance, the current from two machines gave 15,000 candles, as measured by red light. For these and higher candle-powers it was found convenient to remove the dispersion photometer to a distance of 100 inches from the arc.

The illuminating powers given by the current from two machines were then found to be 13,500 candles by red light, and 23,200 candles by blue light.

The illuminating powers of the current from three machines driven in parallel circuit were 16,000 candles by red light, and 31,000 by blue light; and when the two machines fed the arc and drove the third machine as a motor, the illuminating power was 17,300 candles as measured by red light.

TABULAR STATEMENT OF RESULTS.

	E.M.F. at the arc.	Current.	Watts in the arc.	Candles.	
				By red light.	By blue light.
With one machine	33	175	5,775	8,000	16,000
With two machines	35·5	275	9,750	13,500	23,200
	36	278	10,000		
With three machines	37	300	11,100		
	42 to 32	300	11,000	16,000	31,000
	41 to 37	310	11,600		
With two machines driving the third as a motor	52 to 41	240 to 285	12,000	17,300	

TWO YEARS AFTER.

THE extracts in the first column under are from a report of the first board of the Gülcher Electric Light and Power Company, published in the REVIEW for September 2nd, 1882, those in the second from a report issued by the present board and published in the last issue of the REVIEW.

September, 1882.

"On the 16th June an agreement was entered into with Mr. Willam Crookes, F.R.S., by which the company undertook to purchase his incandescent lamp upon very favourable terms. The directors congratulate the shareholders upon having acquired this light, as an incandescent lamp is indispensable for household lighting, and they consider Mr. Crookes's lamp by far the most perfect invented, both as regards durability and economy. The directors have also the pleasure to announce that Mr. Crookes has accepted a seat on the board, and they feel assured that the company cannot but derive great benefit from the services and advice of such an experienced and well-known electrician."

"A special factory has been constructed at Battersea for the manufacture of Crookes's incandescent lamps, where they are now being made, and in a short time it is expected that they will be turned out at the rate of over one thousand per week."

"As regards Mr. Crookes's lamp, it is the best yet produced, and we have purchased it on very favourable terms. Mr. W. Crookes, who is one of the first electricians in the country, has become a member of our board; and no doubt his addition to the board is a very great acquisition, as he, at all times, is ready at hand to give us his valuable advice."

November, 1884.

"The same cannot be said of the patent sold to the company by Prof. Crookes. The price paid for the 'Crookes' incandescent lamp was originally £35,000, of which £11,700 was to be paid in cash, and £23,300 in fully paid-up shares of the company. In addition to this, and to use his own words, "as part of his purchase money," £525 per annum was to be paid to Prof. Crookes as consulting electrician, and £500 per annum to his son, Mr. Henry Crookes (for 5 years at least) for superintending the incandescent lamp department. It is true that Mr. Crookes, as above stated, voluntarily surrendered last autumn nearly half the amount of his fully paid-up shares, and more lately he has retired from the post of consulting electrician; but on each occasion he has sought to bind more fast the other fetters which he had placed upon the company, and besides £1,978 paid in fees and salary to him and his son, he has received £7,700 in cash, £4,000 in bonds, and £13,050 in paid-up shares in the company, as the purchase money for his lamp, together with interest up to date upon so much of such purchase money as from time to time has remained unpaid."

"It might have been that even this large price had not been excessive, but the experience of the last twelve months has led the directors to the conclusion that the invention is valueless. Every aid has been given to Mr. Henry Crookes by the board to enable him to turn out a marketable article, and to avoid the necessity of making this report; but notwithstanding that £4,065 has been spent from first to last upon the incandescent lamp department, and notwithstanding the most persevering and intelligent endeavours on Mr. Henry Crookes's part to produce a good lamp, he is unable, and never has been able, and the board see no prospect of his ever being able, to manufacture a marketable article. As may be readily believed, the hands of the directors have been very much tied by being unable to tender with confidence for any installation involving the use of incandescent lamps. In almost all the cases in which it has sold 'Crookes' lamps the company has either had to take them back, or the purchasers have refused to pay for them; so that while the directors could not reasonably recommend lamps manufactured by other makers, they dare not sell their own. This has been a source of the greatest difficulty and injury to the company."

"Under the circumstances above detailed, the directors invited Prof. Crookes to return to the company half his purchase money, and to take back his patents; but this offer having been absolutely refused, the directors have, on grounds which it would be improper to disclose here, brought an action against Mr. Crookes for the return of the whole of the purchase money, with damages for the losses the company has sustained, and they trust that the shareholders will support them in the course they have thought it their duty to pursue."

"With a reasonable capital and a still further reduction of its standing expenses, and by ceasing to manufacture the 'Crookes' incandescent lamp, the directors are confident that a good future would lie before the Gülcher Electric Light and Power Company, Limited."

ELECTRIC LIGHTING IN AMERICA.

By W. H. PREECE, F.R.S.*

ELECTRIC lighting is flourishing in America much more than at home. There are, probably, 90,000 arc lamps alight every night in the States, and there are many central stations working regularly, both with arc and with glow lamps.

On the evening of October 21st I drove from the Windsor Hotel, New York, to the Cunard Wharf, a distance of about four miles, through streets entirely lighted by electricity. On October 30th I drove from Euston to Waterloo without seeing a single electric light, having been on the ocean during the intervening period.

I visited Montreal, Philadelphia, Buffalo, Cleveland, Chicago, St. Louis, Indianapolis, Boston, and New York, finding in each city the principal streets and warehouses, as well as stores and places of public resort, lighted by arc lamps.

It is with arc lighting that the greatest advances have been made in the States. One manufacturer alone told me that he was turning out 800,000 carbons for arc lamps per month, and another said that his output of plant was 50 arc lamps and three dynamos per day; and while I was present at a third factory, an order was received for an electric lighting plant of 330 arc lamps requiring 14 24-light dynamo machines, intended for an installation to light up a driving park in the environs of Chicago.

As an instance of the growth of electric lighting, I may mention that in Chicago the number of arc lamps installed has doubled, viz., from 1,000 to 2,000, during the past 12 months, and the number increases daily. More than one electric light company pays dividends to its shareholders, and all of the manufacturers, as well as the lighting companies, seem to be full of work.

The principal systems in use are, for arc lamps—the Brush, the Weston, the Thomson-Houston; but there are other arc systems, not so well known on this side of the Atlantic, such as the Hochhausen, the Van Depoele, the Western Electric, the Fuller, the Sperry, &c. For glow lamps—the Edison and the Weston.

I.—ARC SYSTEMS.

The Brush System is so well known that it scarcely needs any reference, excepting to point out that a very considerable improvement has recently been made in the dynamo machine, which has very largely increased its capacity and output.

The Weston System.—This system, looked at from a mechanical point of view, strikes one as being probably the best in use in the States. The machine itself is of the Siemens form, but the armature is made up of discs stamped out of thin sheet iron, and separated from each other by washers. By this method, first suggested by Joule in 1843, those disturbing induced currents are entirely checked, and thereby the undue heating of the armature prevented. Mr. Weston appears to have been the first to have practically carried out this very sensible idea, and it is being rapidly adopted by other makers of dynamo machines. I have mentioned that Mr. Brush has followed out the same idea.

The 200-lighter Weston dynamo for glow lamps is peculiar in the extreme lowness of the resistance of the armature, which is only ·0011 ohm, while the resistance of the shunt is 24 ohms, thus having a ratio between them of 1 to 2182. The result of this lowness of resistance is such that the resistance of the armature may be neglected, and therefore the dynamo becomes self-regulating. I saw 199 lamps out of 200 suddenly extinguished, without producing any apparent change in the incandescence of the one glow lamp left. The electromotive force of this machine is 70 volts when rotated at 1,000 revolutions per minute.

The arc lamps of the Weston type do not call for special notice, excepting to record the remarkable steadiness of their burning.

The beautiful suspension bridge at Brooklyn is lighted entirely by 82 Weston lamps.

Local companies using the Weston arc system are successfully operating central stations, supplying a large number of lights for rental at Boston; Springfield, Manchester; Providence, Rhode Island; Newport, Rhode Island; New York City, Rochester; Elmira and Glen Falls, New York; Newark, Cape May; Atlantic City, &c.

The Thomson-Houston System.†—This system is unknown at present in England; it contains some considerable and ingenious novelties.

The Hochhausen System.—This is slightly known in England, from its employment in the recent International Health Exhibition to light up the tall mast in the centre of the gardens. It is doing a large business, but I did not visit any places worked by it.

Central Stations.—I visited the central station of the Thomson-Houston Company at Montreal. When I was there, there were 164 arc lamps alight in the public streets and shops of the town. The wires through the town were all of copper, principally No. 6 gauge, covered with cotton and asbestos, and were in all cases carried through the streets on unsightly posts. The rate charged is 50 cents per lamp per night, the lamps being lighted from dark to midnight; this means over £35 per lamp per annum.

I visited other central stations worked on this system, and I learned that it was decided to light up the public streets of Ottawa entirely by the Thomson-Houston system.

Another central station that I inspected was that of the Brush system, at Philadelphia; there 1,200 horse-power was employed in supplying electricity for nearly 1,000 lamps. As in Montreal, open wires are used, supplying 25 circuits, some of which are four miles long. The charge for each lamp is 25 dollars per month, which is equal to £60 per lamp per annum.

The Brush people have also two central stations at Boston, lighting up 816 arc lamps: in fact, there are few towns of any consequence in the States which do not possess central stations worked by the Brush Company. There are, probably, 25,000 Brush arc lamps in use in the States.

At Chicago there are now over 2,000 arc lamps going, and they are increasing in number every day. The Lincoln Park has all its drives lighted by arc lamps, with very great effect, especially on the unique drive skirting the shore of Lake Michigan. There are several central stations belonging to various companies in Chicago, viz., the Western Electric, the Van Depoele, the Fuller and the Sperry Company; while the Hochhausen system is about to be started with a central station for several hundred lamps.

I did not observe any particular novelty in the form of lamps used, and the impression I gained was, that there were some European lamps that far surpassed the American ones in steadiness and efficacy.

Street Lighting.—In every case arc lamps were used for this purpose, and they were usually fixed on much taller posts than we are accustomed to see in England, arranged in zigzag fashion along the streets, at a distance from each other of about 50 yards. Although the effect of this street lighting by arc lamps was brilliant, it was by no means perfect, and no effort seems to have been made to distribute the light uniformly.

An interesting experiment has been tried in Cleveland, where eight Brush lamps are fixed upon the tops of four iron masts, each about 250 feet high, fixed in prominent positions in the city. I am bound to say that, to me, the effect was very poor; the streets were illuminated only by a light equal to a very pale moonlight, concentrated, as it were, at one end only. There are 300 other arc lamps in Cleveland.

Washington has been experimentally illuminated by the Brush-Swan Electric Light Company, by very large arc lamps, 4,000 candle-power each, fitted with large conical reflectors, throwing a great body of light down the streets to be illuminated. The various avenues radiating from the capitol are thus lighted, and a circle of 14 lights, without reflectors, surrounds the top of the capitol, the effect of which, I am told, is certainly very fine. I have since learned, however, that, after an experimental run of forty-five days of these lights, the commissioners empowered to decide upon the success of the experiment have given their veto against its continuance.

It is, perhaps, interesting to point out that the price paid in New York is 70 cents per night, or £50 per annum for each arc lamp; but a fine is inflicted on the lighting company of 1·40 dollars for each time that each lamp is reported to have been out; a healthy check is thus kept upon the good working of the system.

II.—INCANDESCENT SYSTEMS.

Incandescent lighting in America does not seem to have flourished to the same extent as arc lighting, nor indeed has it been applied to private houses to the same extent that it has in England. The principal system in practical use is that of Edison. Some incandescent lamps have recently been introduced by Mr. Weston that promise to be very efficient indeed. They are made from a material that Mr. Weston calls "Tamadine," the result of some secret process upon nitro-cellulose.

The Swan Lamp is extensively used, principally by the Brush Company.

The Bernstein, a new lamp, which was exhibited at the Health Exhibition, is also commencing to get a footing in the States.

House Lighting.—House lighting has been attacked principally by the Edison Company. The Edison Company have a grand central station in New York, which was opened on the 3rd September, 1882, and during the whole of the period that has elapsed from that time to the date of my visit, there had been only two and a half hours' stoppage, that being due solely to carelessness. A commodious building in Pearl Street is applied to this purpose.

There are now 587 subscribers, using altogether 12,764 lamps, served day and night; and the present arrangements of the company are quite inadequate to supply all the applicants who desire the light. The price charged is the same as that which would be paid if gas were supplied at 7s. 9d. per 1,000 cubic feet, but there is every reason to believe that the rate is too small, and does not give a sufficient margin of profit. The price of gas is 9s. 2d. per 1,000 cubic feet. It is interesting, however, to know that the system is worked at a profit, and that during the past twelve months the balance on the right side has been sufficient to pay a dividend of 3 per cent. on the capital invested, but no dividend has yet been declared. The earnings per lamp-hour are 1·04 cents, while the cost of production for the same period is ·75 cents. The average number of hours of lighting appears to be 2·4 per day per lamp. A record is kept of every lamp, so that the average life is known, and it comes out at about 477 hours.

The average number of lamps per subscriber is twenty-one, while the average amount paid annually by each subscriber is £40.

The difficulties that have occurred in practical working have arisen principally from a too free use of fuses, which have given much trouble by going when they ought not to go. The conduc-

* Paper read at the Society of Arts, Wednesday, December 3rd.

† The most exhaustive description of this system yet published in any journal will be found in the ELECTRICAL REVIEW for November 15th and November 22nd of the present year.—EDS. ELEC. REV.

tors have, unfortunately, been fitted with bad joints, and a good deal of annoyance has arisen from leaks in the mains; but all these effects are due to immature experience, and can readily be remedied in future extensions.

The distribution of the currents is carried out by a network system of double mains which involves the use of an immense weight of copper. Dr. Hopkinson in England, and Mr. Edison in America, have shown how an economy of 60 per cent. in the weight of copper used can be effected by using three wires and two dynamos.

The whole area of the portion of the city lighted by this system is about a quarter of a square mile, it covers fifty blocks of buildings and fifteen streets, and the capital invested is £200,000. It is intended to open two more central stations, of much larger dimensions, in the upper part of New York, and there is no doubt that with the experience gained, the troubles encountered in the old station will be remedied.

At Roselle, I saw an interesting installation—this is a small village in New Jersey. There, 1,200 lamps were used, supplied by three dynamo machines joined up in series; the lamps also being worked in three series. Overhead wires were used, and the charge was 1 cent. per hour for each 10-candle lamp; this is equivalent to gas at 2·5 dollars per 1,000 cubic feet.

Another very interesting central station, wired up on the new 3-wire system, was established at Brockton, a town about 17 miles from Boston. There were 2,090 lamps going, and 1,040 were about to be started. The station was installed in October, 1883, with 250 lamps, and the rate charged was 1 cent. per hour for each 10-candle lamp. There were 108 subscribers. The capital of this company is 100,000 dollars, 25 per cent. of which belongs to the parent company. The station has not yet carried a dividend, but the expenditure balances the receipts. The business is growing at such a rate, that there is no doubt that, at the end of the second year, a handsome balance will be realised.

I also inspected two large central stations in New York, worked on the Weston high tension system. One station worked 384 arc lamps, while the other was working 500 arcs and 1,750 glow lamps. All the details of these two stations manifested the same mechanical skill and solid appearance that I have already alluded to as indicative of the Weston system.

Conductors.—In all cases throughout the whole of the States, with the exception of the Edison system, the conductors are invariably aerial wires, generally of copper, protected to a certain extent with cotton or hemp covering, and supported by poles fixed along the kerbs of the streets. The high tension currents are always used, and up to the present moment the freedom from danger has been very marked. A considerable amount of trouble has been caused to the telegraph and telephone companies, by these powerful electric light currents finding their way into the telephone and telegraph circuits by contacts. I traced no less than seven fires in offices which were undoubtedly due to these causes.

Secondary Batteries.—The use of secondary batteries has not received so much attention in the States as on this side of the water. The form most generally in use is that of Mr. Brush, which is a modification of the Planté cells, and is said to give very good results. Another modified Planté I saw in use at Philadelphia, made by Dr. Starr. The experiments that have been made with the Faure secondary battery were not well spoken of.

Instruments for Measuring Purposes.—The point connected with electric lighting to which I devoted a considerable amount of attention, was the practical working of Edison's method of measuring the current used, by the electrolytic action of a small portion of the current upon two zinc electrodes immersed in a solution of sulphate of zinc.

The bottles containing the solution and the zinc electrodes are collected every month, and in the Edison district of New York, two men are employed whose sole duty it is to collect and measure these "meters." The plate which has suffered loss of zinc is removed from each bottle of the meter, dried, and carefully weighed. The mean between the two measurements is taken as the true one, and this weight of zinc lost, in milligrammes, multiplied by a co-efficient, gives the number of dollars to be charged for the light consumed during the month. The charge made to the consumer, though based on the current supplied, is really charged on the light given, and it is 1 dollar per 1,000 candle-hours. The weight of zinc lost is made equivalent to so many candle-hours, and the subscribers, therefore, pay for the light they receive and not for the current they use.

There are 1,160 bottles out, 50 of which are measured every day. No trouble whatever is experienced in measuring them, and they are unquestionably accurate within 1 per cent., which is more accurate than any existing gas meter. The consumers themselves have taken various steps to check the reliability of the meter returns, and the result has been that the public has gained confidence in the accuracy of the measurements and the charges made.

Electric Lighting of Ships.

The electric light has been applied to a great extent to the lighting of ships. The great ferry boats of the Pennsylvania Railroad are so lighted. Those magnificent hotel steamers that ply between New York and Fall River; and those on Lake Superior, as well as those on the Mississippi and other large rivers, are either wholly illuminated, or are gradually being fitted for that purpose. The fittings on such a steamer as the *Bristol* are very complete, and were carried out by the Edison Company. All the great passenger steamers crossing the Atlantic are being fitted, and the comfort to passengers in consequence is inestimable.

General Commercial Position.

The problem as to whether electric lighting is practical, and as to whether that means of illumination can be made to pay, has been thoroughly solved in the United States. The Edison Company started on the basis of the charges made for gas, and the result of the two years' working has been to show that this was a financial mistake. Electricity must earn its future success entirely upon its merits and not on its economy. In the case of street lighting it has proved itself to be a good thing, and if once a thing is proved to be good in America, it is immediately taken up. "Progress," in that country is the word.

I have said, more than once, that at the present day we can only regard the electric light as a luxury, and we must pay for it as a luxury. But there is no reason why it should always remain a luxury. There are various chances of economy which justify the conclusion that, sooner or later, the price will be brought down so as to relieve us of the use of the term luxury as applied to it. For instance, the output of the dynamo can be extended, which has already been done with several types, particularly, as I have pointed out, in the case of the Brush pattern, where 60 arc lamps are now lighted where only 40 lamps were supplied by the earlier and unimproved machine.

Again, considerable reduction in the weight, and therefore in the cost of the conductors has been made by the production of the three-wire system. Moreover, when existing patent rights lapse, the manufacture of dynamos will become general, and the consequent competition will, no doubt, result in the production of efficient machines at a sum far below the cost of those made under existing patent rights.

The efficiency of the glow lamps has also been very considerably affected by the improvements made, for instance, by Messrs. Woodhouse and Rawson, and by Mr. Bernstein. The efficiency of the Edison lamps means the consumption of energy at the rate of five watts per candle with an equal life, but lamps are now being made which give an efficiency of 2·5 watts per candle, which is equivalent to an immediate reduction of 50 per cent. in the amount of energy required to maintain the system alight, and, therefore, at the cost of its production.

There is still vast room for economy, and it is quite clear that the prices which are now necessary to make the electric lighting pay, must not be regarded as final; they will be brought down.

Even now it is possible, in England, to make a system pay at the rate of a halfpenny per glow lamp per hour; and no one who has ever experienced the charm and comfort of the electric light, and who has electricity brought to his door, and supplied to him at this rate, would hesitate to pay that figure for the use of electric lamps, although he could obtain the same light by gas at less than half the price.

NOTES.

Electric Lighting.—A grand fancy fair in aid of the Hospital for Sick Children was held last week in St. Andrew's Hall, at Glasgow. The building was lighted by eight powerful Pilsen arc lamps, two groups of three each being suspended from the ceiling of the large hall, whilst two single arc lamps were placed on high Venetian masts at each side of the Duchess of Montrose's stall in front of the organ. These lamps illuminated the "old street" in a manner which gave a bright clear moonlight effect. The arc lamps were especially suitable in this case, as they were arranged so as to obscure the architectural features of the hall, which contrasted badly with the old style of the decorations. The stalls were illuminated by 250 Swan and Pilsen incandescent lamps, in the arrangement of which there was a great variety of designs, such as figures holding groups of illuminated flowers, together with tasteful electroliers in the form of pendants and standards. The arc lamps were supplied with current from a Pilsen dynamo, and the incandescent lamps from a Victoria Brush dynamo. The installation, which ran successfully throughout the week, was carried out under the direction and management of Mr. J. L. Crawford, by Messrs. Anderson and Munro, of Glasgow; Principal Jamieson, of the College of Science and Arts, Glasgow, kindly acted as consulting electrician.

We last week reprinted from the *New York Electrical Review* a note respecting the failure of the lights in Philadelphia in connection with which the Callender Co.'s patent cable was used. A later number of our contemporary contains the following:—"Upon investigation we find that the Callender underground cable, laid by the Brush Electric Light Company in Philadelphia in a few inches of loose sand, to avoid the payment of a

certain city tax upon cables laid in boxes, was against the advice of the Callender people, who always provide a trough filled with their patent bituminous compound, laid in which none of their cables have ever failed. Economy did not prove a good policy in this case."

The large erecting shop of the Coalbrookdale Iron Company, Salop, has been lighted by the Gülcher Company by means of one 3,000 C.P. and two 1,000 C.P. arc lamps, driven by a No. 1 dynamo. These have rendered the large shop, which is 180 feet long and 40 feet wide, almost as light as day, enabling gas to be totally dispensed with, and, although the machine is driven from the same engine as the shafting, which, of course, is somewhat irregular in speed, the lights are giving great satisfaction.

The same company is lighting the rag-sorting department of Messrs. E. Fox and Son's establishment at Dewsbury, in which 32 20-C.P. incandescent lamps are used, driven by a No. 1 dynamo. An arc lamp is also in use for lighting the yard.

The Patent Shaft and Axletree Company, of Wednesbury, has enlarged its plant, which now consists of five 3,000 C.P. and six 2,000 C.P. arc lamps, driven by a No. 4 Gülcher dynamo.

The mouth of the Pentwys Colliery Company's pit is being lighted with a 3,000 C.P. Gülcher arc lamp, which has taken the place of large fires, consuming from 10 to 15 cwt. of coal per night, and is expected to effect a considerable saving. The offices are lighted with incandescent lamps.

Messrs. W. I. and C. S. Young, of Salisbury, have placed an order with the Gülcher Company to light their saw mill with incandescent lamps. As they have ample power available, it is anticipated that this will save them a considerable amount of money.

The Consolidated Electric Company, Limited, of Cow Cross Street, is publishing estimates for installations of from 20 lamps of 20-C.P. to six arc lamps of 2,000 C.P. and 100 20-C.P. incandescent lamps upon its storage system.

The death of M. Vaucorbeil, late director of the Grand Opera of Paris, and the approaching election of his successor at the National Academy of Music, says a correspondent of a contemporary, will bring about the discussion of a large number of questions of interest, one of the more important of which will specially affect the immediate future of electric lighting in Paris. The work of illuminating the Grand Opera by electricity has been eagerly sought, for several years, by the various electric lighting companies, and has been looked upon as the central point of departure for various proposed combinations for public lighting of different adjacent quarters from one great power station. Some months ago the Edison Company proposed a general scheme to provide for lighting the Opera, on an extensive area around the central station, which was to be placed in the Rue Caumartin. The number of lamps to be supplied by this station was estimated at 22,000, distributed among private houses, cafés, clubs, &c., which are numerous in this part of Paris. Of the total number, 6,000 were to be used in the Opera. The central station was to contain engines of 2,500-horse power, provided with steam by a group of Belleville boilers, and fourteen dynamos, as well as ample secondary battery capacity. This extensive scheme, the cost of which was estimated at 2½ millions of francs, has made no substantial progress, and has indeed been laid aside to await the arrival of better times. The death of M. Vaucorbeil has revealed a considerable deficit in the working expenses, a deficit that results from the enormous charges of all kinds, and which the liberal public support accorded to the management, and the heavy subsidy granted by the State, were powerless to overcome. It seems probable, therefore, that any electric lighting scheme will be adjourned indefinitely along with several others that would involve expenditure. It is moreover stated that under the new direction, the Ville de Paris will accord a subvention in relation to the supply of gas, which will be furnished at a reduced price.

Messrs. Lewis & Co., of Liverpool and Manchester, one of the first firms to adopt electric lighting, both as an illuminant and an attractive advertisement, have lately made use of electricity as an attraction in another form, viz., an electric carriage, which is at present exciting much curiosity in Liverpool and Manchester. It is an attractively painted carriage illuminated with 12 lamps of 10 C.P. each, placed as follows: one on the horse's head, three on the coachman's hat, two in the carriage lamps, six on the roof. The current is supplied by 12 small accumulators manufactured by the Electrical Power Storage Company, and supplied by the Electric Apparatus Company, Limited, Queen Victoria Street. These small cells have a storage capacity of about 60 ampère hours, and have lately been much used for electric lighting on a small scale.

The electric light was installed at the Corporation Galleries, Glasgow, on Saturday last.

The Royal Polytechnic Christmas Exhibition, Glasgow, is to be electrically illuminated.

Last week, at Coupar Angus, Professor Stegall, of University College, Dundee, delivered a lecture on electric lighting.

Telephone Competition.—Hitherto all attempts at competion with the owners of the Bell and Edison patents have ended in speedy absorption or disastrous loss. How far opposition to their monopoly may be successful we will not venture to predict, but there are signs that it is about to be seriously attempted. We have very little sympathy with professors who take out patents, and as a caution to others should not regret failure on their part to obtain commercial success for their inventions. It is a matter of indifference to us whether Professor Thompson and his associates are successful or otherwise in their proposed new telephone company, but if the result of their operations should be to cause the United Company to deal with the public in the liberal spirit with which they have been dealt with by the Government, we shall have cause for satisfaction.—*Mechanical World.*

The Telephone in Brazil.—After two years of bitter competition in the telephone business in Rio de Janeiro, Brazil, between the Companhia Telephonica de Brazil and the Companhia de Telegraphos Urbanos (the former having 800 subscribers, and the latter about 750), a basis of consolidation has been arrived at.

Lancashire and Cheshire Telephonic Exchange Company, Limited v. The Overseers of the Poor of the Township of Manchester.—This case, heard on appeal before the Master of the Rolls and Lord Justice Lindley, on Tuesday, raised an important question as to whether telephonic apparatus is ratable. The appeal was by the plaintiffs from the judgment of Mr. Justice Mathew and Mr. Justice Day, affirming a rate whereby the plaintiffs were rated in respect of the whole of their telephone posts, or other supports or attachments, and all the wires thereto attached, taken as one entire system. The Master of the Rolls, in giving judgment dismissing the appeal, said that the things fixed occupied so much of the buildings, and therefore so much of the soil as was necessary to keep the things in place. The things were the exclusive property of the company, for whose benefit alone they were fixed. In such circumstances the company was the exclusive occupier of the things, and therefore it was in occupation of part of the land and was ratable. Lord Justice Lindley concurred. Leave was given to appeal to the House of Lords.

Telephone Patent Action.—We learn that Major W. C. Barney has brought an action against the United Telephone Company for an injunction to restrain that company from publishing any statement that the Boult telephone is an infringement of the patent rights of that company; and he also asks for damages for injury done to him by advertisements to that effect lately published by the United Telephone Company.

The American Bell Telephone Company v. The People's Telephone Company (Drawbaugh Patent).—We understand that the first-named company has gained a verdict in this suit.

Cheap Telegrams.—In the Legislature at Montpelier a bill has been introduced to compel telegraph companies to send all messages of less than 25 words for 15 cents, and granting free delivery within one-half a mile of an office.

Telegraphic Extension.—Arrangements have been made with the North British Railway Company to open its offices at Aberfoyle and New Killearn for telegraph business. The opening of these two offices will be a great boon to tourists and others.

Telegraph Revenue.—The receipts from April 1st to November 29th, 1884, amounted to £1,220,800; from April 1st to December 1st, 1883, they were £1,215,000.

The Commercial Cable Company.—The New York common council has passed a resolution over the mayor's veto, granting to the Commercial Cable Company the right to lay pneumatic tubes and electric conductors under the streets of the city, in consideration of which the company agreed, among other things, to pay the city 1 cent per lineal foot for so much of the streets as was torn up.

Oriental Telephone Company, Limited.—A requisition was addressed to the board of this company about a fortnight ago by a number of shareholders, demanding that a general meeting be convened in order to consider the propriety of appointing a committee of investigation with full powers to examine into the affairs of the company. The requisionists also propose to increase the number of directors "by appointing five additional directors or any less number, such increase not to involve any increase of the directors' remuneration." The directors have now fixed the date of the meeting for December 22, and the requisionists have issued a circular, explaining their views, which we give in our City Notes. The directors have replied, intimating their intention to oppose the resolutions, and have also issued a report by the auditors, which they consider satisfactory.

The Antwerp International Exhibition, 1885.—Her Majesty's Consul at Antwerp has been appointed British Commissioner for this exhibition, and Mr. P. L. Simmonds, whose office is at 35, Queen Victoria Street, is the Agent-General for Great Britain and Ireland.

Another Gas Explosion.—A serious gas explosion, by which three persons were injured, occurred at Broadmead Chapel, Bristol, on Monday. The wife of the chapel-keeper had occasion to go with a light into the vestry of the chapel, and immediately upon entering an explosion took place by which she and her two sons, who were with her, were so terribly injured that they had to be removed for treatment at an hospital. The vestry was shattered, the door and walls being blown down.

The Electric Lighting Act.—The suggestion made by the president of the Board of Trade to the deputation which recently waited upon him, that clauses should be submitted to the Board of Trade embodying the desired modifications of the Electric Lighting Act and Provisional Orders, is to be acted upon, and a committee consisting of representatives of the various electric lighting interests is being constituted to draw up such clauses.

The ss. "Monarch."—This Government cable ship is now at Port Glasgow, where she is to undergo extensive alterations by Messrs. D. J. Dunlop & Company, her builders.

Mr. Preece on Electric Lighting.—In the paper read by Mr. Preece before the Society of Arts last Wednesday, there occurs a paragraph which is very likely to mislead the uninitiated. In speaking of the chances of economy which justify the conclusion that prices will be so reduced as to relieve us of the term "luxury," when applied to electric lighting, he says:—"The output of the dynamo can be extended . . . . in the case of the Brush pattern, where 60 arc lamps are now lighted where only 40 lamps were supplied by the earlier and unimproved machine." Naturally the only economy is in the purchase of a machine, but the passage we have quoted might make some persons believe that 60 arc lamps can now be worked at the same cost as 40 from an inferior dynamo. As each lamp requires about 1 H.P. it follows that there is no economy in the working price.

A New Brush Armature.—In order to obtain more lightness, coolness, and efficiency from the armature of the Brush dynamo, the American makers have introduced a core built up of iron riband instead of the old solid cast-iron core. A long band or riband of iron, ·0625 in. thick, is wound round a circular frame, and at intervals between each turn, cross-pieces of the same thickness are inserted to separate the convolutions admitting air, and at the same time projecting on each side so as to form the V-shaped projections which hold the coils in place and separate them from each other. About forty-five turns of the band are laid on. The new form is said to enable the machine to supply fifty arcs instead of the forty obtained from the older form at the same speed, namely 750 revolutions per minute.

Colliers and their Lamps.—At Walker Colliery, near Newcastle, the miners have been asked to take down Marsaut lamps instead of the old Clanny and Davy lamps, but have objected and struck to the number of 300, leaving the colliery idle.

Transmission of Power.—For the experiments in the electrical transmission of power between Paris and Creil by the system of M. Marcel Deprez, to which we alluded a fortnight ago, we are informed that it has been decided to use a cable manufactured under the Berthoud-Borel patents, of which the Kinetic Engineering Company is the sole licensee in this country, and an order has been given for 78,000 metres (49 miles) to be delivered forthwith. The cable is to carry a current of 20 ampères with an electromotive force of 7,500 volts, equal to 150,000 watts or 200 H.P.

The Society of Telegraph Engineers and Electricians.—The annual general meeting for the election of council and officers for 1885 will be held at the Institution of Civil Engineers, 25, Great George Street, Westminster, S.W., on Thursday, December 11th. A paper "On Electricity in America, 1885," will be read by W. H. Preece, F.R.S., Past-President.

Inventors' Institute.—The meeting at Lonsdale Chambers, Chancery Lane, next Monday, will be devoted to the discussion of the Patent Act, 1883, section by section, commencing with Part I. Section I. The chair will be taken at 8 p.m. by Vice-President Admiral Selwyn. The discussion will be continued on January 12th, 1885. Gentlemen not being members who wish to attend should apply to the secretary.

Utilisation of Niagara.—The *Buffalo Express* states that the Bell Telephone Company has two wires connected with Niagara Falls, by means of which the exchange at Buffalo has recently been operated. As an experiment a generator was placed in the paper mills of Quimby & Co., at Niagara Falls, and the machine connected with 20 miles of wire; the result has been a success.

Gold Medal.—Messrs. Woodhouse & Rawson have been awarded a gold medal for their exhibit in class 26 in the International Health Exhibition.

The Rowland Hill Benevolent Fund.—In connection with this fund, which has for its object the relief and assistance of post office employés distressed from poverty, age, or infirmity, and of their widows and orphans throughout the United Kingdom, the Lord Mayor has opened a special fund at the Mansion House, to be called "The Fawcett Memorial Fund," for the benefit of those employés or their widows or orphans who may be afflicted with blindness.

The Fatality from Electricity.—The engine driver at Messrs. Bolckow, Vaughan and Company's steel works, at Eston, who met with his death as recorded by us last week, imagining that an arc light had "gone out," touched the lamp with the apparent purpose of adjusting the carbons. In the absence of expert evidence it is difficult to assign a cause for this mishap, but it probably arose from simultaneous contact with the positive and negative sides of the lamp while the arc was broken, or from defective insulation elsewhere in the circuit, enabling a derived earth current to be made through the body of the unfortunate man. In either case, says the *Mechanical World*, the system is at fault, and if it is found impracticable to effectively insulate every part of a high tension circuit, steps should be taken to prohibit the use of series lighting with all its advantages.

The Transmission of Electricity.—At the suggestion of M. Cochery, the President of the French Republic recently issued a decree creating a commission which will report on the best measures to adopt in fixing the conditions to be complied with in the interests of public safety, for the installation of conductors for the distribution of high currents. This commission, presided over by M. Cochery, consists of MM. Hervé-Mangon, Jamin, Alphand, Delmas, Gariel Sartiaux, Mascart, Mille, Marquis de Braza, Jousselin, Guillaume, Bergon, Blavier, Georges Cochery, Cael, and Raynaud. At its first meeting the following programme was agreed upon:—1. To consider the precautions that should be taken when conductors are laid in the sewers or otherwise underground, above or along buildings, &c., and for their introduction and fixing within houses. 2. To prepare a list of conditions to be complied with on the part of contractors having charge of the installation of conductors intended for the transmission of power or light. 3. To ascertain the natures of wires, cables, and methods of insulation which should be preferably employed in such installations. 4. To determine the resistance offered by the wires according to their sections, to the resistance of the current. 5. To fix the maximum current to be transmitted through conductors. 6. To recommend the best instruments for measuring the force of the current transmitted, and to determine a practical mode of control. 7. To suggest the necessary precautions to be taken by workmen when repairing conductors, so that they may not be exposed to danger.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Company, Limited.—At an extraordinary general meeting of the members of this company, held at 8, Argyll Street, Regent Street, on the 18th of October, it was resolved that the liquidator of the company, Mr. George Charles Vincent Holmes, be empowered to sell and transfer to the Railway and Domestic Lighting Company the goodwill, stock in trade, and assets of the company in consideration of six fully paid shares of £100 each in the said Railway and Domestic Electric Lighting Company, Limited, and £300 cash. The resolution was confirmed on the 17th ult., and filed on the 27th ult.

Great Western Electric Light and Power Company, Limited.—The annual return of this company, made up to the 20th October, was filed on the 26th ult. The nominal capital is £195,000 divided into 78,000 shares of £2 10s. The number of shares issued is 24,744, upon which £2 10s. has been called up; the calls paid are stated to amount to £22,000, and nothing remains unpaid. Since the filing of the last return, the capital of the company has been reduced from £250,000.

Consolidated Telephone Construction and Maintenance Company, Limited.—The annual return of this company, made up to the 6th of June, was filed on the 1st inst. The nominal capital is £300,000 in £1 shares. The number of shares issued is 224,850, including 45,835 issued to the vendor. 200,000 shares (including vendors shares) are fully paid, and 17s. 6d. per share has been called upon the remaining 24,850 shares, the calls paid upon which amount to £21,743 15s.

Change of Office.—The registered office of the French Electrical Power Storage Company, Limited, is now situate at 14, George Street, Mansion House.

NEW COMPANY REGISTERED.

Elwell-Parker, Limited.—Capital £50,000, in £10 shares. Object: To acquire the business of electricians and engineers lately carried on by Paul Bedford Elwell and Thomas Parker, of Wolverhampton, trading as "Elwell and Parker," and "The Wolverhampton Electric Light Storage and Engineering Company." Signatories: Charles Moseley Ardwick, Manchester, 100 shares; W. A. Turner, Pendleton, Salford, 100 shares; J. Crewdson Waterhouse, Portland Street, Manchester, 100 shares; J. Moseley, Ardwick, Manchester, 100 shares; T. W. Gillibrandt, George Street, Manchester, 1 share; V. K. Armitage, Swinton Park, near Manchester, 1 share; J. G. Sharples, 13, Lincroft Street, Manchester, 1 share. The vendors are appointed first directors. Mr. Elwell will be entitled to £300 per annum, and Mr. Parker to £500 per annum, as remuneration for their services. Registered 29th ult. by Mr. T. Parker Dixon, 13, Gray's Inn Square.

Standard Electric Light and Power Company, Limited.—Capital £300,000, in £10 shares. Objects: To acquire the exclusive right for Great Britain and Ireland (other than Scotland), to use and dispose of electric piles or batteries constructed in accordance with a process patented by Felix de Lalande, dated 27th March, 1882, and numbered 1464; also to purchase the Letters Patent, No. 40, dated 1st January, 1884, for improvements in galvanic batteries, and the utilisation of the products therefrom. Signatories, with one share each: *Charles Stuart Blair, 3, Pall Mall Place; *R. H. Baillie, M.R.C.S., 7, Albermarle Street; *T. Rome, Charlton Kings, Glo'ster; S. Mure Fergusson, Stock Exchange; E. Dowdeswell, 63, Malvern Road, Dalston; H. Moon, 34, Filey Crescent, Stamford Hill; W. H. Ray, 18, Constance Street, East Road. Directing qualification: 50 shares. Remuneration: a sum not exceeding £1,000 per annum. Registered 3rd inst. by Phelps, Sidgebick and Beddle, 18, Gresham Street.

* Signatories whose names are preceded by an asterisk are also directors.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, November 27th, Prof. W. G. Adams, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, the President stated that a telegram had been received from Dr. Davy, acknowledging the honour which had been conferred on him by his election as an honorary member

of the society. The discussion on Dr. Hopkinson's and Prof. Adams's papers was then resumed.

Dr. HOPKINSON stated that he had requested that a note might be added to his paper when it was printed in the Proceedings of the Society, with reference to Mr. Wilde's paper, published in the *Philosophical Magazine*, to which his attention had been called.

Mr. BLAKESLEY explained how several of the problems dealing with the action of dynamo-machines could be treated geometrically, and he gave examples showing how the effects of self-induction could be thus calculated. The working of alternate-current machines through cables would, he pointed out, result in considerable diminution of effect through the electrostatic capacity of the core; he calculated that on a particular wire 1·8 miles long and insulated with Hooper's India rubber, the effect on a dynamometer placed at the further end, would be only half that shown at the nearer end, the alternations of the current being 200 per second.

Mr. GISBERT KAPP asked in the case mentioned by Mr. Blakesley, where did the lost power go to? In some experiments he had made with a solenoid of 3 ohms resistance and an alternating-current machine, showing 100 volts, a current of 10 ampères was obtained, or a power of 300 watts, whereas 1,000 watts should have been given. He would ask what became of the other 700 watts?

Mr. SHOOLBRED did not consider alternating current machines to be satisfactory, since storage with them was, of course, impossible. The danger, moreover, from shocks was very great.

Mr. R. E. CROMPTON enquired what would be the effect of self-induction in a network of mains as regards the running together of a number of alternate current machines at different points.

Mr. MORDEY asked whether alternate current or direct machines were the most economical.

Prof. ADAMS said that with reference to the question of shocks, one of the enginemen at the South Foreland had received the full shock from a 75 volt alternating current machine but without injury.

Dr. HOPKINSON, in replying, said that, with reference to Mr. Kapp's query, no energy was actually lost, the method of calculation which apparently indicated that it was, being incorrect. There was no conclusive evidence, he contended, to prove that alternating current machines were really more dangerous than those which gave direct currents. It was true that all the fatal accidents had occurred with alternating current machines, but this was probably due to the fact that such machines had hitherto always been made to give a very high and the direct current machines a low, potential.

The meeting then adjourned.

CITY NOTES, REPORTS, MEETINGS, &c.

Gülcher Electric Light and Power Company, Limited.

THE second annual general meeting of this company was held at the offices, 4, Coleman Street, E.C., on Thursday afternoon. Mr. Daniel de Castro presided, and in moving the adoption of the report, which we have already published, added to his motion the following: "That the sum of £162 11s. 2d., part of £1,776 18s. 10d. standing to the credit of trade and other debts on the 30th September, 1884, and the sums of £850 12s. 6d., £125, and £85 11s. 7d., part of the sum of £1,953 19s. 1d., respectively standing in the books of the company to the credit of directors' fees, Mr. Henry Crookes' salary and Mr. William Crookes' fees and loans of interest, be treated as claims only." In explaining his reasons for adopting this unusual form, the chairman stated that the report and balance-sheet issued by the first board represented the capital as £168,517 10s.; the liabilities were £172,738 12s. 6d.; alleged creditors, £19,313; plant and machinery were represented at £7,830; stock, £12,300; trade debtors, £1,106; and cash at the bank, £2,560. At a meeting held on the 25th August, 1883, the shareholders were asked to pass these accounts. He (the chairman) objected, representing those *bonâ fide* shareholders who were dissatisfied. Upon his first protest a poll was taken, and was carried against him by gentlemen who, he alleged, were not *bonâ fide* shareholders. It was sufficient for him to say that as to the holders of about 50,000 or 60,000 in value of the votes which carried that meeting, they were no longer shareholders. He also protested against certain fees and certain amounts being carried to credit on the balance-sheet; he did not want to have it recorded that the report and accounts were adopted and approved of. The shareholders never did approve of that account, though in the books it appeared as having been approved. On the 25th of September of the same year a difference arose as to the validity of the votes which preponderated at that meeting; they were held virtually by one gentleman, to whom he should refer further on. He then said, "I hope it will be put on the minutes that we, the dissenting shareholders, claim a majority in the number you have attested. We impugn a large number of votes given on the other side." That was all they could do then; they were in a minority. That being so, he had asked them not to treat all the credits which appeared in the books as credits, but to treat some of them as claims only, and claims which the present directors were bound to represent as credits, though they considered them only claims. On September 28th, 1883, when the new board was finally elected, the position of the company was a very different one to that represented by the balance sheet. The liabilities were much greater than the £19,000 mentioned; there was a bill of sale on the property for over £11,000; the cash balance was £227 instead of £2,600, and out of that £227, on the Tuesday when they took office, they had to pay over £170 for the wages of the week. The fifth call had been made, and that fifth call had been mortgaged to the same gentleman who held the bill of sale over the property. Before they had been in office three weeks they were informed by the award of an arbitrator that they were to pay £1,000 and costs within ten days. That £1,000, it appeared, was a subject of arbitration of which the shareholders knew absolutely nothing. He confessed he did not then think they would last a month, but they went round to *bonâ fide* shareholders and honestly told them all the difficulties, with the result that from a number of the powerful shareholders they received unlimited support; they gave them their calls in advance, and lent further sums. With money so raised they had pulled the company round to its present position. A committee of investigation from the board was appointed, and the result was that within three months of this, the shareholders against whom he had protested "threw up the sponge;" they gave up £75,000 in account—£70,000 absolutely—of the purchase money, which was supposed to have gone into the hands of "poor Mr. Gülcher," and they then thought they saw a possibility for the company. Mr. Crookes, upon its being represented to him that his position was so much improved by these negotiations with the promotors, voluntarily and unreservedly gave up £10,000 of his shares to further reduce the liability of capital. Mr. Gülcher and Mr. Groth responded in an equally handsome manner, and the capital was reduced from £196,000 to £90,000. The balance sheet before them was a miserable thing; but it was the best they had been able to do, and it was not so bad as it looked. The shareholders had paid into their coffers £54,910 on the 30th September last. There were at that time 27,087 ordinary shares with £3 10s. called up. Of these, 16,000 shares had paid up or had had called upon them £3 10s. per share, amounting to £56,000; there were arrears of calls in respect of those 16,000 shares, amounting to £4,269; but there were calls which had been paid in advance to the extent of £2,875. There were 13,000 other shares upon which there ought to have been £42,000 paid. Of these, 9,377 had been wholly surrendered, and the remainder would have to be surrendered. In the spring of this year he induced some of the shareholders to pay up all their unpaid calls, and others to take debentures. The £10,000 debentures which they had authority to raise were not altogether allotted on the 30th September; but £9,000 had been virtually allotted. There were £193 due upon current bills, and there were trade and other debts, £1,776; directors' fees, salaries, loans, &c., £1,953. On the other side they had patents on their books, after writing off nearly £20,000, as of the value of £55,000. They knew the value of patents if they came to be sold in liquidation by public auction! There were plant and tools, £5,800; stock, £18,000. The convertible assets were £125, bill; £1,447, trade debts; £17 7s., cash at the bank. If ever a balance sheet was enough to make a shareholder's blood run cold this was it—at first sight. But he would read to them between the lines. On the 30th June, 1883, the balance sheet showed £15,000 arrears of calls; their balance sheet showed £4,269 in one account and £4,682 in another. The arrears of calls had been gradually reducing, and before the litigation of which he should have to speak, there had been received £1,350; therefore what did not appear as an asset was a very valuable asset indeed. They had now reduced that £4,269 to £2,919, of which £2,919 they were fairly entitled to consider one-half as good. Then, when litigation was instituted, they had received £250 more on account of debentures issued, but not allotted. And from the £1,447 trade debts, they had at the date of the litigation received no less than £1,195. The liabilities certainly amounted to £3,924; of this trade creditors were entitled to £1,776, and directors' fees, &c., were £1,953. The resolution which he should submit would explain that what appeared to be a debt, from an accountant's point of view, was more than half of it a claim only and a disputed claim. Their position according to a balance sheet prepared down to the very latest moment, for the purpose of affidavit, was this: they owed £9,950 to debenture holders; they owed £106,000 to shareholders, paid and unpaid; and they had no other debt in the world that they knew of. Every shilling had been paid, and there was at that moment £125 receivable upon bills; there was £1,180 due from trade debtors; and there was £769 14s. 3d. in the bank. He had treated the patents as worth nothing; but he was of opinion that the Gülcher patents were of very great value. A very large proportion of the £18,000 of stock was, he must also explain, income-earning stock—stock which was out on hire. As soon as the accounts went out, down came litigation upon the company. There was an action by Mr. Crookes, their late consulting electrician, the vendor of one of their patents, who moved for a receiver and manager. He was anxious about the security of the £4,000 debentures which he held. The company appeared to the action, and stated a few facts; but the Vice-Chancellor stated that the facts were no answer to the action, and Mr. Crookes, as a mortgagee, was entitled to interest on security. That interest must be paid; but he would make no order for receiver or manager. He gave them a week to pay £120, and after the next board meeting it was paid. Next day came a petition by his son for the winding up of the company. Then came another petition by Mr. Norton. These gentlemen alleged insolvency; and in order to prove that they were not insolvent, they paid every debt, and several of their creditors, disgusted at the manner in which attempts had been made to make them

partisans in a shareholders' quarrel, subscribed for debentures. The chairman then alluded at some length to the failure of Mr. Henry Crookes to manufacture the Crookes incandescent lamp, alleging that every facility was given him to enable him to do so. He himself, long after the other directors had become dissatisfied and desirous of discontinuing the manufacture of the lamp, insisted that Mr. Crookes should have ample time allowed him; and on no occasion was anything refused which Mr. Crookes stated that he required. After the Long Vacation he (the chairman) went abroad, and when he came back he found that his co-directors had resolved upon bringing an action against Mr. Crookes. After repeated unsuccessful attempts to settle the matter and avoid litigation, he felt it was his duty to the shareholders to concur in the action brought by his co-directors. That action was not upon the contract. They went behind the contract. There were representations made, which had not been confirmed by results, which induced the directors to enter into that contract to purchase for a very large sum Mr. Crookes's patent. In conclusion he moved the resolution already given.

Major Cotton seconded.

Replying to questions, the Chairman said Mr. Crookes stipulated in his agreement that his son should be appointed manager of the incandescent lamp department at a salary of £500 a year. The chairman considered Mr. H. Crookes's salary as part of the purchase money, and they would charge that in the action. The board had not taken any independent opinion respecting the value of the Crookes lamps; they had called in no special assistance; they were satisfied that it was a commercial failure.

Mr. H. Reeves moved as an amendment to the resolution that the report and accounts be received, but not adopted, and that the meeting be adjourned to that day five weeks in order that the shareholders might have an independent investigation.

Mr. Davidson seconded.

The Chairman stated that a postponement would involve the loss of orders they were almost sure of getting, and would result in almost total ruin to the company.

The amendment, however, was insisted upon, and was put, only the mover and seconder voting for it.

Mr. Davidson demanded a poll, and put in proxies, which were sufficient in number to make good his demand. After a postponement to that day week for the purpose of taking the poll had been decided upon, a letter was received from one of the shareholders whose proxy Mr. Davidson had stated he held, notifying that Mr. Davidson was not authorised to vote for him.

It seemed there had been a misapprehension, and the chairman then ruled that the demand for a poll was not upheld by sufficient votes. The original resolution was then put and carried. The directors were re-elected, and one of the auditors, after which the meeting terminated in a vote of thanks to the chairman.

The Railway and Electric Appliances Company, Limited.

ON Thursday afternoon last, an extraordinary general meeting of the shareholders of the above company took place at Cannon Street Hotel, under the presidency of the chairman of the Company, Colonel Raynsford Jackson.

The secretary of the company, Mr. William Shepherd, having read the notice convening the meeting, the report was taken as read.

The Chairman said: Gentlemen, I shall endeavour to occupy as little of your time as possible in my preliminary remarks, but I shall be prepared to answer any questions that may be put by any shareholder and to deal with any matters that may be brought before the meeting. The object that the directors have had in view in negotiating the arrangement which you are asked to confirm, is to take one more important step in the direction of getting the company out of the realm of litigation which has been the bane of its career hitherto; and this compromise together with the compromise which you agreed to on April 18th, will have the effect of making a material change in the capital position of the company. The shares that will be cancelled by the compromise which you are asked to sanction number 41,681, and the capital paid upon them has been £20,975 12s. 6d. You are asked by payment of £4,000, to get rid of the liability of £20,975 12s. 6d. If you agree to the proposal, the capital position of the company will be as follows:—There will be 28,450 fully paid-up shares, and 50,051 ordinary shares upon which 12s. 6d. has been paid, the share capital of the company being £78,501 against £172,232 which it stood at before the two compromises; and the capital which would rank for dividend or for participation in the assets of the company in case of liquidation, will be £60,256 7s. 6d. against £131,282. You will see, therefore, that the two compromises will materially improve the position of those shareholders who remain. I am sorry to say that the directors have reason to be extremely earnest in urging you to get your affairs out of the hands of the lawyers. They attend meeting after meeting, and a large portion of their time is devoted to dealing with matters of liquidation without any connection with the business proper of the company, and, what is most sickening to them, to see what probably might be made a good business, injured and depressed by quarrels amongst ourselves, and what I cannot help characterising as needless and ruinous obstruction. (Hear, hear.) Gentlemen, I will now move the report of the directors and the following resolution: "That the directors be authorised and requested to compromise all or any actions pending against the company on such terms as they deem expedient, including the removal of the plaintiffs or any of them from the register of members, and the payment out of the funds of the company of not exceeding £4,000 in respect of the compromise of claims of £20,000 or upward."

Sir Edward Inglefield seconded the motion.

Mr. James Murray said that he had received a circular from Mr. Williams as to some action he intended to take in this matter; but as Mr. Williams did not seem to be present, he would like to ask whether the company was parting with any of its patents in making the compromise.

The Chairman said that they were not; when they had made arrangements with the vending companies, when they acquired their patents, by which they gave up 50,050 fully paid up shares, the condition was that as regards the Williams Company, the Williams patents should be re-transferred to it, and as regards the National Electric Company, the license to manufacture its patents should also be cancelled. But that was all discussed at the previous meeting and formed no part of the subject they were met to consider.

Sir E. Inglefield said it would be satisfactory to know what funds were in hand for the purpose of liquidating the company's liabilities.

The Chairman said he had a statement showing roughly, and as nearly as one could arrive at without stock taking, the position of the company. On November 18, they had in cash, at the bank, £2,237 4s. 2d.; in the secretary's hands, £100; debentures, £3,875; book debts, say, £1,100; buildings at Polmadie estimated at £4,032 2s. 4d.: plant and machinery estimated at £2,896 8s. 3d.—together £6,928 10s. 7d.; stock estimated £4,310; furniture in London, say, £150; at Polmadie £70; patent for waggon cover costing £300, and an amount due from Messrs. Latimer Clark and Muirhead (which they dispute) £1,000; total £20,170. On the other hand there were liabilities to the amount of £8,474, including the £4,000; so that would show a balance in favour of the company of from £10 to £11,000 irrespective of uncalled up capital which they hope not to have to trespass upon, which would amount to about £19,000. Including the debentures they had £6,000 available, and the Polmadie works which were free from mortgage, and they might get £2,000 or £3,000 from these latter to carry on the business of the company.

In reply from a farther question from Sir E. Inglefield as to the annual expenses of the company, the chairman said that the expenses at Polmadie, £2,100, had been reduced to £600. The business of the company had very materially altered in two or three respects. The Williams' patent showed signs of becoming more valuable. The Wemyss Bay Company had given them a second order, and they had enquiries from other companies, and there were indications of an increased business in the Williams' cross-overs and other appliances of which they had the monopoly. Then in the six months, up to the end of October last, their average loss had been £91 a month, as against £270 a month during the previous six months. But during some of these later months there had been a slight profit, and if a balance sheet were struck for the last three months, including November, he was given to understand that there would be no loss at all, so that they were gradually and steadily improving the position of the company, and if there were any improvement in trade he thought they would arrive at a period of profit. (Hear, hear.) The statements he had made had not taken into account the expenses in London. Formerly the expenses in London for offices and salaries were £1,050, and for stationery £100. That had been reduced to £560, and arrangements had recently been made whereby a reduction of half had taken place in the company's office rent, in addition to which another party, for partial accommodation in the offices, paid half the rent, so that the rent would be reduced from £400 to £100 a year. They had bought a waggon fastener patent for £250, which had proved so valuable that its return was considerably over the entire price paid for it. He was unable to specify the legal expenses; perhaps £1,500 to £2,000 might cover them.

The resolution was then put to the meeting, and declared by the chairman to be carried with three dissentients.

A desultory conversation ensued, arising out of various questions asked by Mr. Cummings, who explained that he had not been present at the earlier proceedings.

Mr. Bompas stated that the £4,000 which was to be paid for the compromise would extinguish the claim of shareholders who held, rightly or wrongly, that they were entitled to recover from the company £20,000.

The Chairman said that now that the directors had got rid of such grave obstruction they would be able to give attention to the actual business for which the company had been formed, and it was their hope to avoid calling on the shareholders for more money. They anticipated something like a successful business, and they would put themselves in communication with the shareholders before making a call, if it was found advisable to ask for one. He did not think the shareholders would object to such a call if they were able to show them a fair and reasonable prospect of doing a good business with the additional money. He might say that the directors held in the 12s. 6d. fully paid up shares between one-seventh and one-eighth of the remaining capital of the company, so that their interests were entirely identical with those of the shareholders.

In answer to a further question from Mr. Cummings, the chairman said that £60,286 was the amount of the fully paid up shares. The nominal capital was £78,500, £18,750 of which was not yet called up.

The proceedings then terminated, after the chairman had expressed his obligations for the vote of thanks which he understood the meeting had passed.

Oriental Telephone Company, Limited.

MR. THOMAS LLOYD has recently issued the following circular in connection with the requisition mentioned in our Notes columns :—

"Sir,—A large number of shareholders of the above company, owners of shares on which there is still a liability of 10s. per share, have, in accord with me, sent a requisition to the directors, calling upon them to convene an extraordinary general meeting of the company; this step has been taken for the purpose of proposing the appointment of a committee to inquire into the affairs of the company, and of making certain changes in the directorate.

"The reasons which have chiefly determined our action in this matter are the following :—

"The shareholders of the Consolidated Telephone Construction and Maintenance Company last May, appointed a committee of investigation, from whose report it would appear that the directors had so mismanaged the business of the company that it was in grave danger of being wound-up, with the loss of nearly the whole of its capital; so much so that the price of the shares had fallen from £2 10s. and upwards to 2s. or 3s.

"Among the gentlemen affected by this report were:—Colonel Gouraud, the present chairman of the Oriental Telephone Company; P. Carnegy, Esq., one of the present directors of the Oriental Telephone Company; J. P. Bigelow, Esq., also one of the present directors of the Oriental Telephone Company.

"The two former, in consequence, resigned their seats at the Boards of the Consolidated Telephone Company, the River Plate Telephone Company, and the Telephone Company of Austria. Mr. Bigelow had already withdrawn from the Consolidated in February last.

"The committee has since continued its investigations, and your attention is invited to its forthcoming supplementary report.

"With such disclosures before us, common prudence enjoins upon us to inquire whether our affairs are being better managed than those of the Consolidated Telephone Company.

"We know that, as in the case of that company, the shares of the Oriental Telephone Company are greatly depreciated, and as the paid up capital is spent, and the company is in debt, we have reason to fear that a call of fresh capital is inevitable. The amount of the call appears to depend upon the result of our present action. The dividends guaranteed by the Oriental Company on the "A" shares of the Bengal and Bombay Companies alone amount to upwards of £6,000 per annum, whilst as regards other subsidiary companies it seems likely that their earnings will for the present no more than pay their expenses.

"The question is the more urgent because the holding of the two directors, who sold the patents to the company, and who now practically control its affairs, viz., Colonel Gouraud and Mr. Bigelow, is in fully paid up vendors' shares. They, therefore, will not be affected by a call; on the contrary, their shares, like the remaining fully paid up shares, will enjoy an advantage over the ordinary shares, if, by allowing the affairs of the Oriental Company to drift, a liquidation should become necessary.

"On these grounds I venture to ask you to attend the forthcoming meeting and support our motion for investigation and reorganisation of the board; or, if it is not convenient for you to attend, to entrust me with your proxy, of which I enclose a form, which please sign and return to me.

"A copy of the requisition sent to the directors on the 12th instant is annexed; the signatures represent 54,106 shares, although 30,000 only are required by the articles of association. The total assents received up to that time by me and the friends with whom I am acting exceed 100,000 shares.—Your obedient servant, "THOMAS LLOYD.

"40, Hogarth Road, South Kensington, S.W.
"November, 1884.

"The present directors are :—Col. Gouraud, J. P. Bigelow, Esq., James Pender, Esq.; also, T. A. Edison, Esq., residing in America; Hon. G. G. Hubbard, residing in America; Sir Wm. Thomson, residing in Glasgow; P. Carnegy, Esq., on leave of absence till July, 1885."

Great Western Electric Light and Power Company, Limited.

THE directors of this company have issued the following communication to the shareholders :—

"Gentlemen,—Your directors have convened an extraordinary general meeting of the company to consider, and, if thought advisable, to confirm a provisional agreement entered into with the Anglo-American Brush Electric Light Corporation, Limited.

"This agreement embodies an offer, unexpectedly made by the Anglo-American Brush Electric Light Corporation, to take over your Company as a going concern, paying for each Great Western share, 10s. in cash, and 15s. in fully paid Anglo-American Brush shares at par. This offer your directors consider a fair one under existing circumstances, but the responsibility of its acceptance or rejection must, of course, rest with the shareholders.

"It amounts briefly to this: you will receive the bulk of the cash now in hand, and you will receive in Anglo-American Brush shares at par, the full face-value of all your plant, property, buildings, stock of materials, stores, &c., together with about £4,000 for the goodwill of your business. You will thus become partners in the original company, who have excellent works, a well-organised staff, and sufficient capital to carry out successfully contracts of a magnitude that your company could not venture upon with the capital at their command.

"In order to ascertain the value of the Anglo-American Brush shares proposed to be taken in part payment, two of your directors have had an interview with Lord Thurlow, the chairman of the Anglo-American Brush Electric Light Corporation, at which the present financial position and future prospects of the Brush Corporation were fully disclosed; and these are, by your directors, considered sufficiently good to warrant them in laying the present proposals before you.

"Should the proposed amalgamation be carried out, the distribution of 10s. per share in cash, and the issue of the fully paid Anglo-American Brush shares, will take place at an early date. Your chairman, Mr. J. B. Braithwaite, Jun., will also be invited to join the board of the Anglo-American Brush Electric Light Corporation, and he will thus still have an opportunity of watching over your interests.

"Should you decide to reject the offer of the Anglo-American Brush Corporation, your directors will continue to give their best attention to the affairs of your company."

Great Northern Telegraph Company, Limited.—Messrs. C. J. Hambro & Son announce the numbers drawn of 50 debentures (issue 1881), which will be paid on presentation at 70, Old Broad Street, E.C.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of November was 2,746, estimated to produce £2,475, against 2,866 messages, producing £2,580 in the corresponding month of last year. The receipts for the month of August, estimated at £2,375, realised £2,515.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th November, are £2,333, as compared with £2,340 in the corresponding period of 1883. The August receipts, estimated at £4,835, realized £4,909.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 28th, were £2,436; after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company. The receipts for November, 1884, £22,800 and from 1st January to 30th November, 1884, £257,480; for the corresponding months of 1883, £236,469; and for 1882, £223,863.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of November, were £1,736, against £1,781 in the corresponding period of last year.

CORRESPONDENCE.

Spurious Resistance in Armatures.

Will you permit me in a few lines to explain a remark, reported in your columns (p. 429) last week, made by me in the discussion on the theory of the dynamo at Philadelphia. It was made in the course of expounding to the Philadelphia Conference certain points in Professors Ayrton and Perry's theory of the spurious resistance occasioned in rotating armatures in consequence of the self-induction. My remark was that "there must be some term wanting in the calculations of Professors Ayrton and Perry, and that term must be the reciprocal of a time." The passage in Professors Ayrton and Perry's memoir on motors that was in my mind will be found on page 321 of No. xlix of the *Journal of the Society of Telegraph Engineers and Electricians*, where they say : "experiments made to determine the coefficient of self-induction by the Wheatstone bridge method, described by Clerk Maxwell, showed that it" (the coefficient of self-induction) "was about 7·5 ohms." Now as a coefficient of self-induction is a quantity of the nature of a length, and resistance a quantity of the nature of a velocity, it is evident that the coefficient of self-induction must be divided by a certain time-quantity before it can be expressed in ohms. That missing term was supplied in page 319 of the same journal by Professors Ayrton and Perry themselves, though omitted in the passage on page 321. In my "Dynamo-electric Machinery," page 80, I have given Professors Ayrton and Perry credit for this point as well as for the main theory of the spurious resistance.

I think it well to make these explanatory remarks because I understand that my reference to the matter at Philadelphia, and the fuller calculations I there applied, have given rise to the idea that I was propounding some theory of my own in opposition to that of Professors Ayrton and Perry. I need hardly add that, as the whole of my remarks were intended to support

their theory and to defend what seemed a weak point in it against opposition from previous speakers, nothing was further from my intention than the propounding of a rival theory.

Silvanus P. Thompson.

University College, Bristol,
December 2nd, 1884.

The Iron Disc in Bell's Telephone, and its Equivalents.

I fail to find in the letter of "F. T. H." a satisfactory reply to certain of my queries—as suggested in your note appended to my letter of 25th November.

The remarks of "F. T. H." upon the essence of the claim in the Bell patent are, I am inclined to think, based upon the wording of the sixth claim without taking into consideration the alterations introduced into it by the words "but subject always to the disclaiming notes."

By reference to these notes it will be found that there are to be introduced into the claim two important additions.

The first alteration is that the plate shall be attached to a frame; see lines 53, 54, page 10, also lines 49-50, page 2 of disclaimer.

The "Glasgow" receiver was precisely just such an instrument as that described in 6th claim before the disclaimer; and as that famous receiver became public property by reason of its prior publication to Bell's patent, the patent would certainly have been judicially declared to be void; and this was the main defence of the patent relied upon by Mr. Aston for the U. T. Company.

The second alteration is the substitution of the words "equivalent plate" for the word "material."

The 6th claim with these alterations inserted will read—

"The combination in the manner described in the fourth and fifth plans of an electro-magnet with a plate of iron or steel or other equivalent plate capable of inductive action attached to a frame or cup-shaped block (see line 56, page 12), which can be thrown into vibration by the movement of the surrounding air or by the attraction of a magnet."

It will be recollected that Mr. Justice Fry, and also the Court of Appeal, held that the "Glasgow" receiver, with a disc tilted up, was not an anticipation of Bell's patented receiver with a disc held down all round its circumference.

The Bell patent seems to be safe so far as the points adjudicated upon in those decisions; but I am of opinion that its validity is very questionable, on the ground that the scope of the patent was enlarged by the substitution in the disclaimer of the words "*equivalent plate*" for the word "*material*," and on this point I hope some of your correspondents will enlighten your readers.

W. C. Barney.

December 2nd, 1884.

The "Bell" and "Edison" Telephone Patents.

A solution of the questions put by Mr. Barney in his letter in your REVIEW of 29th inst., would, in my humble opinion, be a solution of the mooted questions as to the validity or invalidity of the Bell patent. Before touching upon that solution, I shall venture to offer my views *seriatim* on his several questions.

To his first question, I am not satisfied in my own mind that a stretched membrane, with a piece of iron attached to its centre, is or is not an equivalent of the steel plate; but I am inclined to think it might be considered as an equivalent, because the action of the two are identical, as Mr. Barney writes, and because the stretched membrane, with the iron attached to its centre, vibrates with the voice, and as a tympan is inductive. I have, however, doubts on this point, which I consider a vital one as regards Bell's patent, and I hope some of your scientific readers will be induced to send to the REVIEW their views thereon.

It would seem that in construing strictly the meaning of the words of the 6th claim in the original patent, the plate—the *entire plate*—should be of a material capable of inductive action; but that claim was very materially altered by the memorandum of alterations, by inserting the words, "*but subject always to the disclaiming notes.*" By referring to the disclaiming notes (see page 2, line 52, and page 11, line 3, of disclaimer, 4th edition), it will be found that the words "equivalent plate" were substituted for the word "material," so that the claim must be taken as if those words were in the place of the word "material." The effect of this alteration in the patent may be fatal to its validity.

The sixth claim is also materially altered by the disclaiming note (lines 46, 47, and 48, page 2, same edition of disclaimer), when the iron plate is referred to as A^3 in the drawings being attached to a frame; line 54, page 10. This alteration does not appear to be an enlargement of the scope of the magnet, but was clearly a narrowing of it, and without this alteration the claim would have been invalid, because of the prior publication of the Glasgow receiver; and upon this particular alteration Mr. Aston, counsel for the United Telephone Co., mainly relied to sustain the patent; and the Court of Appeal sustained it only on that particular description of the manner of fixing the plate round its circumference.

Section 18, paragraph 8, of the Patent Act of 1883, is as follows:—"No amendment shall be allowed that would make the specification, as amended, claim an invention substantially larger than, or substantially different from, the invention claimed by the specification as it stood before the amendment."

Now, if by the substitution of the words "*equivalent plate*," any plate would be included which could not be included by the word "*material*," then the scope of the patent has been enlarged, and the consequence is the patent is bad. The elucidation of this point will probably not be arrived at unless by a legal decision.

In reading *between the lines* of the disclaimer by Bell, methinks I can read what was passing in the mind of the inventor when he found it necessary, in order to screen his patent, to disclaim the goldbeaters' skin diaphragm. He no doubt saw that the effect of that disclaimer would be to leave free to the public the use of a plate made of a material not subject to inductive action, unless he struck out the word "material," and substituted the words "equivalent plate," hoping thereby to include any tympan which could be put into vibration by the voice, and could be subject to magnetic influence, other than the membrane tympan which he disclaimed.

To the second question, I feel no reluctance in saying that although the membrane with iron attached is free, and may be an equivalent for the steel plate, yet the steel plate is not free, because it is specifically claimed as an improvement on the membrane.

To the third inquiry I confess my inability to point out wherein these two plates differ from each other.

To the fourth question my answer is "Yes."

To the fifth question, I am of opinion that the use of the equivalent of any part disclaimed is not an infringement of the patent as disclaimed, unless the equivalent used is an equivalent of any part of the patent as disclaimed.

To the sixth question, I am strongly inclined to the opinion that the bar armature, having an end attached to the centre of a stretched membrane, is not an equivalent for the steel plate; and this is the stretched membrane instrument, subject matter of the disclaimer by Bell.

To the seventh question my answer is "Yes."

To the eighth question my reply is the same as to the first question.

To the ninth question, I am clearly of opinion that a disc of wood with a bar armature is an equivalent for the membrane with the bar armature, and is not an equivalent of the steel plate.

In regard to the tenth question put by Mr. Barney: I consider its solution of the greatest importance in a

legal as well as scientific point, and I wait the views of your correspondents upon it.

To your correspondent "F. T. H." I reply that I attribute a "buzzing" sound in the Bell telephone and in any telephone which has an iron plate held down all round its edge to several causes: one to the straining of the molecules of the iron plate caused by its vibrating at the centre, and to the transmitter, also to the induction from neighbouring wires.

The words of Bell's disclaimer are precise, and the tympan disclaimed is called simply "a membrane," but to me it is a question—aye, a very important question—whether that includes every tympan which is of a non-inductive material.

In regard to "F. T. H.'s" remarks touching my remarks on the Hughes microphone, I am quite clear that Hughes's microphone, as used by him, always was attached to tympan, and I shall be pleased if "F. T. H." will describe a Hughes microphone without a tympan which will transmit articulate speech.

I rely upon Mr. Justice Fry's judgment as to what he decided to be a diaphragm or tympan in the Edison patent, and upon that judgment, the testimony of Sir W. Thomson, Sir Frederick Bramwell, Professor Hopkinson, and others, and according to all of these a diaphragm was "something which separates something from something else—that is anything which separates the air above from the material below, or *vice-versa*." The above is a quotation from "F. T. H.'s" letter in the REVIEW of 22nd inst.

Now I am inclined to think that your correspondent, upon reflection, will agree with me that according to Mr. Justice Fry's decision, a Hughes microphone in a resonant case would come within Edison's solitary claim. Did not Sir William Thomson, in his examination before Mr. Justice Fry, say that a microphone lying on a marble slab was the same as the Edison combination. The very broad construction put upon the Edison patent by that judgment will include any microphone placed in any position so that anything would be above or below it.

Now, although Edison disclaimed the resonant case, it is clear that such a case cannot be used in combination with a tension regulator, because Edison has the claim of the combination of a tenison regulator with a diaphragm or tympan.

I assure your readers generally and your correspondent "F. T. H." that the sole view of this correspondence is to arrive at a correct interpretation of Bell and Edison's patent, so far as the opinions of scientific minds can give, and we all must be content to leave to the Courts the judicial interpretation of them. Mr. Strangways and Mr. Handford could no doubt throw a great deal of light about the above matters which would be very valuable.

Common Sense.

December 1st, 1884.

Compound-wound Machines.

In your last issue I see that my friend, Mr. Macgregor, has been taking up the cudgels on my behalf in the matter of compound-wound machines. In the main his statements are correct.

As a fact, though, I do not think my claim to be the first to apply double winding to the *definite purpose of supplying the current at a constant electromotive force* has been successfully set aside; for I pointed out in my book on electric lighting, published in 1879 (and written in 1878), in describing Mr. Brush's "teaser" arrangement, that there were other useful applications than to the purposes of plating; and I had in mind in writing that sentence (p. 83) the double winding I afterwards developed.

But I have no desire to be too persistent in what now has chiefly a bibliographic value. For compound-wound machines have, as to true economy in electric lighting, only a very limited use. It is amply proved by the performance of Mr. Weston's recently introduced dynamos, that, given a sufficiently powerful field and a very low resistance armature, simple shunt-wound machines are self-regulating. The ends to be attained satisfactorily by compound machines are supplying current to a small number of lights in parallel circuit, where the resistance of the armature, as determined by the dimensions of the machines, must be comparatively high, or to the supply of several branch circuits in the electrical transmission of power to a considerable distance from one generator.

As to the supplying of current for incandescent lighting with true economy as a whole system, I have had a painful experience that it is not to be done with any method employing the power obtained from engines directly, because the variation in the speed of the engine is in itself too great for long life of the delicate filaments of the lamps. In the case of the very admirable Edison installation in New York, we are told that the lamps average only 400 hours of lighting, although here probably the greatest care practicable has been taken to ensure steady running and a low incandescence of the lamps. It is a matter of common knowledge to electricians, I suppose, that lamps run from a machine direct, blacken or break much sooner than those in circuits, in which accumulators are interposed. In my professional practice I have during the last two years been in charge of a large installation, partly run from dynamos with accumulators and partly from dynamos directly, and both parts from the same source—a very excellent steam-engine. In the one case no lamps have been broken except by accident; in the other renewal of lamps are the rule. It is for these reasons as to the fallibility of any mode of winding that I hope you will absolve me from undue pertinacity in my claim as to compound winding.

Will you permit me to add a few words in conclusion? I do not think compound-wound machines have been generally constructed on the best principles. It seems to have been overlooked that with both shunt and main coils wound on the same limb of the electro-magnet an excess of iron in the electro-magnet is in practice necessary to secure proper regulation (flatness of curve in diagram). In the method of winding on separate limbs proposed by myself, this excess of iron is avoided, or is afforded by the arrangement of the mass of iron of the main magnet core. Further, in the "tripolar" electro-magnets, as adopted in the Gramme machine for instance, when the separate cores are each devoted to its circuit (and consequent as well upon what has just been stated) there can be used comparatively much lighter electro-magnets with the same armature, in small machines, without danger of sparking; because instead of need of shifting the brushes around the commutator to avoid sparks, *the point of greatest concentration of magnetic field in the pole-pieces is made to shift relatively to the armature* by the increase of magnetism of the main circuit core. Another advantage of the separate system is, that fewer turns of main magnet wire, and consequently less resistance are needed in the main circuit Whilst only few lamps are alight, the shunt magnets are partly muffled by the inert mass of the main magnet cores; when more lights are switched in and more current passes around the main coils, these cores become somewhat abruptly converted from (so to say) keepers to the shunt magnets into magnets, and their rise of magnetism is at nearer saturation somewhat rapid. I think Dr. Ernest Richter has obtained similarly better results with separately wound machines, although the machines he tested were not in the best proportion, as may be judged by his figures.

Mr. Macgregor adverts to my earlier endeavours to make a machine self-regulating in series. This has long been a hobby of mine, but I have only recently attained practical success. My object has been to charge several batteries of accumulators at different stations in series, and to be independent of all switches which do not always perform their office, as well as to supply economically several sections of electrical tramways.

Paget Higgs.

December 1st, 1884.

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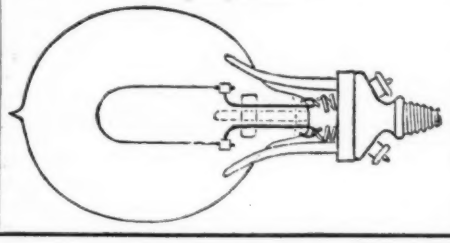

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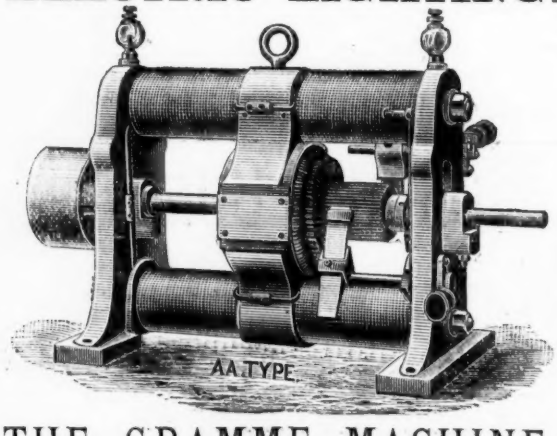

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